

# **Source and Accuracy Profiles**

# Data Source and Accuracy Statements

## Chapter 1 Extent, Condition, and Performance

**TABLE 1-1. System Mileage Within the United States**

### Highway

The Highway Performance Monitoring System (HPMS) is the source of road mileage data and is considered reliable. (See box 1-1 for detailed information about the HPMS.) The Federal Highway Administration (FHWA) of the U.S. Department of Transportation (USDOT) collects and reviews state-reported HPMS data for completeness, consistency, and adherence to specifications. Some inaccuracy may arise from variations across states in their adherence to federal guidelines in the Traffic Monitoring Guide and the *Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Database*.

Beginning with the 1997 issue of *Highway Statistics*, FHWA instituted a new method for creating mileage-based tables derived from the HPMS. Previously, adjustments to tables developed from sample data were made using area-wide mileage information provided by states. These adjustments are now being made using universe totals from the HPMS dataset. In addition, FHWA has discontinued the process of spreading rounding and other differences across table cells. Thus, users may note minor differences in table-to-table totals. FHWA considers mileage totals from table HM-20, “Public Road Length, Miles by Functional System” to be the controlling totals should a single value be required.

Reliability may be diminished for comparisons with pre-1980 data, which were collected via different methods and special national studies. For instance, pre-1980 mileage data included some

nonpublic roadways (95,000 miles in 1979) while post-1980 data reports only public road mileage (roads or streets governed and maintained by a public authority and open to public travel).

### Class I Rail

These data are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). AAR data are based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual Report*. The STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although Class I railroads represent only 2 percent of railroads in the country, they account for over 70 percent of the industry’s mileage.

To obtain railway mileage, AAR subtracts trackage rights from miles of rail traveled on line 57 in the Schedule 700 report. Historical reliability may vary due to changes in the railroad industry, including bankruptcies, mergers, and declassification by the STB. Small data errors may also exist because of independent rounding of this series by AAR.

### Amtrak

These statistics originate from the Statistical Appendix to *Amtrak’s Annual Report*. Amtrak estimates track mileage based on point-to-point

## Box 1-1. Highway Performance Monitoring System

**Sampling Frame Construction**

The Highway Performance Monitoring System (HPMS) sample is a stratified simple random sample of highway links (small sections of roadway) selected from state inventory files. The 1997 sample consists of about 120,000 samples. Each state maintains an independent inventory of highway road links for those roads that the state is responsible for (in some cases this can be a low percentage of total road miles within the state). Lower jurisdictions (MPO's, counties, cities, national parks, Indian reservations, etc.) may also maintain inventories of highway links under their jurisdiction. The HPMS sample was originally selected in 1978 based on guidelines provided by the FHWA for sampling highway systems excluding those roads functionally classified as local. The sampling frame for the state systems were the state inventories. The estimates represent the highway systems of each state. The HPMS sample was designed as a fixed sample to minimize data collection costs but adjustments to maintain representativeness are carried out periodically. The HPMS also consists of universe reporting (a complete census) for the Interstate and the National Highway System, and tabular summary reporting of limited information. A small number of data items (about 30) are reported for the complete universe. The universe information contains no sampling error. There are 4 tables reported as part of the summary.

**Stratification**

The HPMS sample (and universe) is stratified by state, type of area (rural, urban, and individual urbanized areas), highway functional classification, and traffic (annual average daily traffic (AADT) volume groups). Complete information is provided in the HPMS *Field Manual*.

**Weighting**

The HPMS sample expansion factors are the ratio of universe mileage to sample mileage in each strata.

**Data Collection**

Data are collected independently by the 50 states, metropolitan planning organizations (MPOs), and lower jurisdictions. Many of the geometric data items rarely change, such as number of lanes. Others change frequently, such as traffic. Typically, the states maintain data inventories that are the repositories of a wide variety of data items. The HPMS data items are extracted from these inventories. For example, each State has a traffic volume counting program. Typically, equipment is installed or placed on the roads to measure traffic. The counts are then converted to annual average daily traffic (AADT) and stored in the state databases. AADT is one of the sample and universe items extracted from the inventories and reported to the HPMS. The FHWA provides guidelines for data collection in the HPMS *Field Manual*, which the states follow to varying extents depending on issues such as staff, resources, state perspective, uses of the data, state/MPO/local needs for data, etc. Traffic data collection, for example, is an expensive and dangerous undertaking, particularly in high volume urban areas.

State departments of transportation report HPMS data annually to the FHWA. There are about 80 data items reported for the sample component. The reporting deadline is June 15. Except for special cases where major problems occur, data items are reported for each sample. There is no provision for nonresponse since a number is available for each section in the state inventories; however, states do leave items blank to indicate that no data collection has taken place for a specific item (e.g., if no system to measure pavement has been implemented in the state, the pavement condition item may be left blank.) The HPMS has gone through a major restructuring effort, and major data item reductions, modifications, and other changes will begin to be implemented with the 1999 data reported by June 15, 2000.

**Sampling Error**

The sample size is estimated based on traffic volume (AADT) within each stratum. Traffic volume is the most variable data item. Sampling error can be estimated directly based on the sample design for each stratum and aggregated by stratified random sample methods to total values. This exercise was done originally in 1980 for some of the most variable data items including vehicle-miles traveled. It has not been repeated since due to the work involved and the limited impact of sampling error as compared to nonsampling error.

**Nonsampling Error**

This is a major item of concern for the HPMS. For some of the most variable and important data items, such as AADT, guidelines for measurement and data collection have been produced. States have the option of using the guidelines or using their own procedures. Many data items are difficult and costly to collect and are reported as estimates not based on direct measurement. The data are collected and reported by many entities and individuals within the responsible organizations. Most do a reasonably good job, but staff turnover, cost, equipment issues, etc., can create difficulties identifying data problems. As mentioned before, a response is usually provided for each link as included in state inventories. Measurement errors are unknown, but the difficulty of collecting some of the data items is well known. For highway links not the responsibility of states, metropolitan planning organizations and lower jurisdictions using a wide variety of methods may collect the data. This is a major area of concern and efforts are underway within States to standardize data collection. The major effort with the HPMS is to insure the collection and reporting of reliable annual data. The FHWA field offices in each state conduct annual verification of the data reported. Computer software is provided to build the database and conduct logic edits prior to submittal. The reported data are subjected to intense editing and comparison with previous reporting and a written annual report is provided to each state to document problems found and encourage correction. Data resubmittal is requested in cases where major problems are found. The process involves many people and substantial resources, but it provides extensive quality assurance. Complete information on data items, edits, processing, expansion, sample design, definitions, data reporting, etc., is included in the *HPMS Field Manual*.

city timetables that railroad companies provide for engineers. The figures are estimates, but are considered reliable.

**Transit**

These figures are based on information in the U.S. Department of Transportation, Federal Transit Administration (FTA), National Transit Database. Section 15 of the Federal Transit Act requires federally funded transit agencies to provide detailed financial and operating data, including vehicle inventories and directly operated mileage. Transit operators that do not report to FTA are those that do not receive federal funding, typically private, small, and rural operators. The data are generally considered accurate because FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or may misinterpret certain data definitions.

**Navigable Channels**

These statistics originate from a mid-1950s U.S. Army Corps of Engineers (USACE) estimate that there were approximately 25,000 miles of commercially important navigable channels in the United States. That number has been adjusted from time to time, for example, by addition of the 234-mile Tennessee-Tombigbee Waterway in the

early 1980s. The 25,000 plus mile number has been universally quoted for decades, but has definitional and methodological uncertainties. USACE is currently developing a rigorous, Global Information System (GIS)-based approach to facilitate tabulation of the lengths of shallow and deep-draft commercially navigable waterways in the United States; this calculation will be available in several years.

**Oil Pipeline**

The data are from *Transportation in America*, published by the Eno Transportation Foundation, Inc. (Eno). The numbers reprinted here for 1960, 1965, 1970, and 1975 are Eno estimates from the U.S. Department of Energy (DOE) *Energy Data Report* issues labeled “Crude-oil and Refined Products Mileage in the United States.” Eno estimated the 1980 number based on the assumption that refinement of old, less profitable, and smaller lines exceeded in mileage the construction of new, larger, and more profitable lines. Post-1985 data were calculated using a base figure reported in a 1982 USDOT study entitled *Liquid Pipeline Director* and then combined with data from the Association of Oil Pipe Lines and the Oil Pipeline Research Institute. Lack of additional information raises definitional and methodological uncertainties for the data’s reliability. Moreover, the three different information sources introduce data

discontinuities, making time comparisons unreliable.

**Gas Pipeline**

These statistics originate from annual editions of *Gas Facts*, published by the American Gas Association (AGA). The data reported by the AGA are based on gas utilities participation and reporting to the *Uniform Statistical Report*. Utilities reporting represented 98 percent of gas utility industry sales while the remaining 2 percent was estimated for nonreporting companies based on recent historical experience. Varying percentages of nonreporters from year to year introduce minor reliability problems for time-series comparisons.

**TABLE 1-3. Number of U.S. Airports**

The Federal Aviation Administration (FAA), Office of Airport Safety and Standards *Administrator’s Fact Book* (annual issues) furnished the data shown in this table and includes airports certified for air carrier operations with aircraft that seat 30 or more passengers. These airports include civil and joint civil-military use airports, heliports, STOLports (short takeoff and landing), and sea-plane facilities. The FAA obtained this data via physical inspections and mail solicitations of all federally regulated landing facilities. Since this is a census of all U.S. airports, reliability should be high. Data, however, may be subject to reporting errors typical of administrative recordkeeping.

**TABLE 1-4. Public Road and Street Mileage in the United States by Type of Surface**

**TABLE 1-5. U.S. Public Road and Street Mileage by Functional System**

**TABLE 1-6. Estimated U.S. Roadway Lane-Miles by Functional Class**

The Highway Performance Monitoring System (HPMS) is the source of road mileage data and is considered reliable. (See box 1-1 for detailed information about the HPMS.) The U.S. Department of Transportation, Federal Highway

Administration collects and reviews state-reported HPMS data for completeness, consistency, and adherence to specifications. Some inaccuracy may arise from variations across states in their adherence to federal guidelines in the Traffic Monitoring Guide and the *Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Database*.

Beginning with the 1997 issue of *Highway Statistics*, FHWA instituted a new method for creating mileage-based tables derived from the HPMS. Previously, adjustments to tables developed from sample data were made using area-wide mileage information provided by states. These adjustments are now being made using universe totals from the HPMS dataset. In addition, FHWA has discontinued the process of spreading rounding and other differences across table cells. Thus, users may note minor differences in table-to-table totals. FHWA considers mileage totals from table HM-20, “Public Road Length, Miles by Functional System” to be the controlling totals should a single value be required.

Lane-miles are calculated by multiplying the centerline length by the number of through lanes. Because the HPMS requires that the number of lanes be reported for all principal arterials, other National Highway System (NHS) roads, and all standard samples, lane length can be computed for the Interstate, other principal arterials, and the NHS on a 100-percent basis. For minor arterials, rural major collectors, and urban collectors, lane length is calculated based on standard sample sections using the reported number of through lanes, length of section, and an expansion factor. FHWA uses the expanded sample to check that the centerline length of a state’s functional system matches the universe functional system length. If the centerline length and functional system length do not match, FHWA may ask a state to make adjustments.

Reliability may be diminished for comparisons with pre-1980 data, which were collected via different methods and special national studies. For instance, pre-1980 mileage data included some nonpublic roadways (95,000 miles in 1979) while post-1980 data reports only public road mileage (roads or streets governed and maintained by a public authority and open to public travel).

**TABLE 1-7. Number of Stations Served by Amtrak and Rail Transit, Fiscal Year**

These numbers originate from Amtrak's Statistical Appendix to *Amtrak's Annual Report* and the U.S. Department of Transportation, Federal Transit Administration's National Transit Database.

Amtrak maintains a computer database with a record of every station, locomotive, and car it operates. Those records include for each vehicle the year built, its service status (operating or not on a daily basis), and location. These data should be considered very reliable.

**TABLE 1-8. U.S. Oil and Gas Pipeline Mileage**

### Oil Pipeline

The data are from *Transportation in America*, published by the Eno Transportation Foundation, Inc. (Eno). The numbers reprinted here for 1960, 1965, 1970, and 1975 are Eno estimates from the U.S. Department of Energy's *Energy Data Report* issues labeled "Crude-oil and Refined Products Mileage in the United States." Eno estimated the 1980 number based on the assumption that refinement of old, less profitable, and smaller lines exceeded in mileage the construction of new, larger, and more-profitable lines. Figures from 1985 and later years are calculated from a base figure that Eno obtained from the 1982 U.S. Department of Transportation study *Liquid Pipeline Director* and then incorporated that figure with data from the Association of Oil Pipe Lines and the Oil Pipeline Research Institute. Lack of additional information raises definitional and methodological uncertainties for the data's reliability. Moreover, the three different information sources introduce data discontinuities making time comparisons less reliable.

### Gas Pipeline

These statistics originate from annual editions of *Gas Facts* published by the American Gas Association (AGA). The data reported by AGA are based on gas utilities participation and reporting to the Uniform Statistical Report. Utilities

reporting in 1991 represented 98 percent of total gas utility industry sales while the remaining 2 percent was estimated for the nonreporting companies based on recent historical experience. Varying percentages of nonreporters from year to year introduce minor reliability problems for time-series comparisons.

**TABLE 1-2. Number of Air Carriers, Railroads, Interstate Motor Carriers, Marine Operators, and Pipeline Operators**

### Air Carriers

The data are from the *Air Carrier Financial Statistics Quarterly*, published by the Office of Airline Information of the U.S. Department of Transportation, Bureau of Transportation Statistics (BTS). The Alphabetical List of Air Carriers by Carrier Group at the beginning of each fourth quarter edition is used to determine the number of major air carriers and other air carriers in operation at the end of each calendar year. The publication draws its data from the T-100 and T-100(f) databases maintained by BTS. These databases include data obtained from a 100-percent census of BTS Form 41 schedule submissions by large certificated air carriers, which are carriers that hold a certificate issued under section 401 of the Federal Aviation Act of 1958 and that (1) operate aircraft designed to have a maximum passenger seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds or (2) that conduct international operations. Carriers are grouped as major, national, large regional, or medium regional based on their annual operating revenues. The thresholds were last adjusted July 1, 1999 and the threshold for major air carriers is currently \$1 billion. The table combines the number of national, large regional, and medium regional air carriers into the other air carrier category.

### Railroads

The Association of American Railroads (AAR)'s *Railroad Ten-Year Trends* series is the source for the number of railroads. The number of Class I railroads is based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual*

*Report.* The STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although Class I railroads represent only 2 percent of railroads in the country, they account for over 70 percent of the industry's mileage.

The Association of American Railroads through an annual determines the number of non-Class I railroads, comprehensive survey sent to every U.S. freight railroad. By following up with nonrespondents, the AAR obtains essentially a 100-percent census of all railroads. Use of the current survey instrument began in 1986.

### **Interstate Motor Carriers**

The Motor Carrier Management Information System (MCMIS), maintained by the U.S. Department of Transportation, Federal Motor Carrier Safety Administration, contains information on the safety of all commercial interstate motor carriers and hazardous material (HM) shippers subject to the Federal Motor Carrier Safety Regulations and the Hazardous Materials Regulations. All carriers operating in interstate or foreign commerce within 90 days of beginning operations must submit a Form MCS 150, Motor Carrier Identification Report. Carriers may use the form to update their information. The Motor Carrier Safety Improvement Act of 1999 requires that reports be periodically updated, but not more than once every two years. MCMIS is updated on a weekly basis, and periodic archives are not made. Historical data are only available from summary information previously prepared, including tables and reports. MCMIS began operations in 1980, but data prior to 1990 are not available. Data since 1990 are available on a fiscal year basis (October through September). As MCMIS data are from a 100-percent census, they are believed to be very accurate.

### **Marine Vessel Operators**

The U.S. Army Corps of Engineers (USACE) provides the data for marine vessel operators through the *Waterborne Transportation Lines of the United States*. Data are collected by the USACE's Navigation Data Center (NDC) by various means, including the U.S. Coast Guard's registry, maritime service directories, and waterway sector publications. However, an annual survey of companies that operate inland waterway vessels is the principle source of data. More than 3,000 surveys are sent to these companies and response rates are typically above 90 percent. However, a USACE official did report that less than 10 percent of the total number of companies operating inland water vessels either did not receive or respond to the annual survey.

### **Pipeline Operators**

The Office of Pipeline Safety (OPS) in the U.S. Department of Transportation's Research and Special Programs Administration collects annual report data from natural gas transmission and distribution operators as required by 49 CFR 191.17 and 191.11, respectively. Annual data must be submitted by March 15 of the following calendar year. No annual report is required for hazardous liquid pipeline operators. However, information is available through the pipeline safety program. Since 1986, the program has been funded by fees assessed to each OPS-regulated pipeline operator based on per-mile of hazardous pipeline operated. Data for each operator and each mile of pipeline are stored in the OPS user-fee database, which is revised annually as updated fees are assessed.

Totals for pipeline operators in this table will differ from those in other tables due to differences in the regulatory authority of USDOT and the Federal Energy Regulatory Commission (FERC). FERC regulates only interstate pipelines, whereas DOT regulates both interstate and intrastate pipelines, except for rural gathering lines and some offshore pipelines, which fall under jurisdiction of the U.S. Coast Guard or the U.S. Department of the Interior's Minerals Management Service. An OPS official stated that FERC regulates about two-thirds the amount of pipeline mileage that USDOT regulates.

**TABLE 1-9. Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances****TABLE 1-11. Active Air Carrier and General Aviation Fleet by Type of Aircraft****Air Carrier, Certificated, All Services**

Data are from the U.S. Department of Transportation, Federal Aviation Administration (FAA), *FAA Statistical Handbook of Aviation*. U.S. air carrier fleet data are based on reports collected by FAA field offices from carriers. The reports include information on the number of aircraft by type used in air carrier service. The FAA points out that this information is not an inventory of the aircraft owned by air carriers, but represents the aircraft reported to the FAA as being used in air carrier fleet service. The reported aircraft are all aircraft carrying passengers or cargo for compensation or hire under 14 CFR 121 and 14 CFR 135.

**General Aviation**

The 1960-1980 figures originated from the *FAA Statistical Handbook of Aviation*. Later data are from FAA annual issues of the *General Aviation and Air Taxi Activity (GAATA) Survey* report, table 3.1. The FAA collects both aircraft registration data and voluntary information about aircraft operation, equipment, and location. Before 1978, the FAA mandated owners to annually register their aircraft for the Aircraft Registration Master File. This was a complete enumeration of operating aircraft. Registrants were also asked to voluntarily report information on hours flown, avionics equipment, base location, and use. The FAA changed their data collection methodology in 1978. The annual registration requirement became triennial and the General Aviation Activity and Avionics Survey was initiated to sample aircraft operation and equipment data.

The General Aviation Activity and Avionics Survey was renamed the General Aviation and Air Taxi Activity Survey in 1993 to reflect the fact that the survey includes air taxi aircraft. This survey is conducted annually and encompasses a stratified, systematic design from a random start to generate a sample of all general aviation aircraft in the United States. It is based on the FAA registry as

the sampling frame. FAA established three stratification design variables in the survey: 1) the average annual hours flown per aircraft by aircraft type, 2) the aircraft manufacturer/model characteristics, and 3) the state of aircraft registration.

**Data Reliability**

Because of the change in 1978, the reliability of comparisons over time will be affected. The FAA asserted that the change to a triennial registration deteriorated the Aircraft Registration Master File in two ways. First, the resulting lag in registration updates caused the number of undeliverable questionnaires to steadily increase over the three-year period. Second, inactive aircraft would remain in the registry, inflating the general aviation fleet count. In addition, a new regulation added two categories of aircraft to the general aviation fleet. However, FAA concluded that these changes resulted in no more than a five-percent error in the fleet population estimate.

The reliability of the GAATA survey can be impacted by two factors: sampling and nonsampling error. A measure, called the standard error, is used to indicate the magnitude of sampling error. Standard errors can be converted for comparability by dividing the standard error value by the estimate (derived from sample survey results) and multiplying it by 100. This quantity, referred to as the percent standard error, totaled seven-tenths of a percent in 1997 for the general aviation fleet. A large standard error relative to an estimate indicates lack of precision and, inversely, a small standard error indicates precision.

Nonsampling errors could include problems such as nonresponse, respondent's inability or unwillingness to provide correct information, differences in interpretation of questions, and data-entry mistakes. Readers should note that nonresponse bias might be a component of reliability errors in the data from 1980 to 1990. The FAA conducted telephone surveys of nonrespondents in 1977, 1978, and 1979 and found no significant differences or inconsistencies in respondents' and nonrespondents' replies. The FAA discontinued the telephone survey of nonrespondents in 1980 to save costs. Nonresponse surveys were resumed in 1990, and the FAA found notable differences and



thus adjusted its fleet estimates. The 1991 through 1996 data have been revised to reflect nonresponse bias. In 1997, a sample of 29,954 aircraft was identified and surveyed from an approximate population of 251,571 registered general aviation aircraft. Just over 65 percent of the sample responded to the survey.

### Highway, Total (registered vehicles)

The 1960 to 1980 figures are from the U.S. Department of Transportation, Federal Highway Administration (FHWA) document, *Highway Statistics, Summary to 1985*, table MV-201 and related tables. Data quality and consistency will be less reliable for these years because of a diversity of registration practices from state to state. Users should recognize that motor vehicle statistical information is not necessarily comparable across all states or within a state from year to year. For instance, the FHWA reported that separate data on single-unit trucks and combinations was unobtainable from all states in 1990.

After 1980, the FHWA began to use the Highway Performance Monitoring System (HPMS) database, which improved data reliability. FHWA reviews state-reported HPMS data for completeness, consistency, and adherence to these specifications. Some inaccuracy may arise from variations across states in their adherence to federal guidelines in the *Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Database*.

If choosing to compare state data, the FHWA recommends that users carefully select a set of peer states that have characteristics similar to the specific comparison. Improperly selected peer states are likely to yield invalid data comparisons. Characteristics that a user needs to consider in determining compatibility of a peer state include similarities and differences in urban/rural areas, population densities, degrees of urbanization, climate, geography, state laws and practices that influence data definitions, administrative controls of public road systems, state economies, traffic volumes, and degrees of centralization of state functions. The FHWA has developed a set of variables that users may use to determine appropriate peer states.

### Other 2-Axle 4-Tire Vehicle (truck)

Sources for these figures included FHWA's *Highway Statistics, Summary to 1995* (table VM-201A) and annual issues of *Highway Statistics* (table VM-1). FHWA compiles these figures from the U.S. Bureau of the Census' Truck Inventory and Use Survey (TIUS). Since 1963, Census has conducted the TIUS every five years with the last survey completed in 1997. The Census Bureau changed the name of the survey to the Vehicle Inventory and Use Survey (VIUS) in 1997. The VIUS collects data and the physical and operational characteristics of the nation's truck population. In 1997, 131,000 trucks were surveyed from an estimated universe of over 75 million trucks. Chronological reliability may be diminished due to sampling design changes in 1977, 1982, and 1992. In 1977, the sampling universe was first stratified by the number of trucks in a state: large (> 1.5 million trucks), medium (700,000 to 1.5 million), and small (< 700,000); and then by two truck sizes.

Stratification in 1982 was then based on body type rather than vehicle weight. In 1992 and 1997, the sampling universe was first subdivided geographically and then into five strata: 1) pickups, 2) vans, 3) single-unit light, 4) single-unit heavy, and 5) truck tractor. Cases were then selected randomly within each stratum.

Census delivered a mail-out/mail-back survey to the owner identified in the vehicle registration records. Data collection is staggered as state records become available. Owners report data only for the vehicles selected. In the 1992 survey, a method was employed to also collect data on new truck purchases in the latter half of the year to estimate the fleet for the calendar year. This adjustment in the sampling frame had not been done in previous surveys and may diminish chronological reliability. The sample for 1997 was some 22,500 vehicles smaller than for 1992. The 1997 VIUS had two sampling stages. For the first stage, the Census Bureau surveyed about 131,000 trucks registered as of July 1, 1997. The second stage sampled a total of 3,000 truck owners with state mailing addresses different from the state of truck registration.

The accuracy and reliability of the VIUS survey depends jointly on sampling variability and non-sampling errors. Standard errors arising from sampling variability can be converted for comparability by dividing the standard error value by the estimate and multiplying it by 100. This quantity, referred to as the percent standard error, totaled two-tenths of a percent in 1992 and 1997 for the VIUS sample. A large standard error relative to an estimate indicates lack of precision and, inversely, a small standard error indicates precision. The 1992 TIUS achieved over 90.2 percent reporting and the 1997 response rate equaled 84.5 percent, thus reliability may have decreased in the most recent survey.

### Transit

The American Public Transit Association (APTA) provided these data, which are based on the Federal Transit Administration (FTA), National Transit Database. These data are generally accurate because the FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or may misinterpret data. APTA conservatively adjusts FTA data to include transit operators that do not report to the database (private, very small, and rural operators).

### Railroad (all categories)

The data are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). AAR data are based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual Report*. Thus, data estimates are considered very reliable. The STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the adjusted threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although Class I railroads represent only 2 percent

of railroads in the country, they account for over 70 percent of the industry's mileage.

AAR determines the number of non-Class I railroads through an annual, comprehensive survey sent to every U.S. freight railroad. By following up with nonrespondents, the AAR obtains essentially a 100 percent census of all railroads. Use of the current survey instrument began in 1986.

### Amtrak

Amtrak maintains a computer database with a record of every locomotive and car it operates. For each vehicle, those records include the year built, service status (operating or not operating on a daily basis), and location. This data should be considered very reliable.

### Water Transportation

The source for Inland Nonsell-Propelled Vessels, Self-Propelled Vessels, and flag passenger and cargo vessels is the U.S. Army Corps of Engineers (USACE), *Waterborne Transportation Lines of the United States*, annual issues. Data are collected by the USACE's Navigation Data Center (NDC) by various means, including the U.S. Coast Guard's registry, maritime service directories, and waterway sector publications. However, an annual survey of companies that operate inland waterway vessels is the principle source of data. More than 3,000 surveys are sent to these companies, and response rates are typically above 90 percent. However, a USACE official did report that less than 10 percent of the total number of companies operating inland vessels either did not receive or respond to the annual survey.

### Oceangoing Steam Motor Ships

*Merchant Fleets of the World*, published annually by the U.S. Department of Transportation, Maritime Administration (MARAD), is the source of these data. MARAD, which classifies vessels as merchant based on size and type, compiles these figures from a data service provided by Lloyd's Maritime Information Service (LMIS). The parent company, Lloyd's Register (LR), collects data from 200 offices worldwide, from data transfers and agreements with other classification societies, from

questionnaires to ship owners and ship builders, from feedback from government agencies, and from input from port agents. According to an LR official, consistent data-gathering methods have been maintained for more than 30 years. The same official did caution that there are sometimes inconsistencies in groupings of ship types over time. For example, propelled tank barges are now included in the tanker ship-type grouping.

### Recreational Boats

*Boating Statistics*, published annually by the U.S. Coast Guard (USCG), is the source. The USCG derives these figures from state and other jurisdictional reporting of the actual count of valid boat numbers issued. In accordance with federal requirements, all 55 U.S. states and territories require motor-powered vessels to be numbered. However, over half the states do not require non-powered vessels to be numbered. Accuracy can also be diminished by noncompliance of boat owners with numbering and registration laws. In 1996, the USCG estimated that approximately eight million recreational boats are not numbered and, thus, are excluded from the reported number of recreational vessels. The USCG did not provide estimates for the number of boats without numbering in their 1997 and 1998 reports. Some jurisdictions fail to report by publication deadlines, and the USCG provided estimates based on the previous year's estimate.

**TABLE 1-10. Sales or Deliveries of New Aircraft, Vehicles, Vessels, and Other Conveyances**

### Civilian Aircraft

The Aerospace Industries Association (AIA) provided this data in their annual issues *Aerospace Facts and Figures*, "Civil Aircraft Shipments." AIA collects their data from aircraft company reports, the General Aviation Manufacturers Association (GAMA), and the U.S. Department of Commerce's (DOC) International Trade Administration. DOC data provide total number of shipments and exports, and the difference computed

by AIA equals domestic shipments. DOC collects shipments data separately for individual factories or establishments and not at the company level. A potential limitation of this approach is when a factory producing aircraft for shipment also makes aircraft parts. If the establishment has 80 percent of its production in aircraft and 20 percent in parts, all of the output is attributed to aircraft shipments.

### Transport

The Aerospace Industries Association (AIA) is the source of these data. AIA obtains quarterly data from Boeing Corp., now the sole U.S. manufacturer of transport aircraft, and publicly available financial disclosure information filed with the U.S. Securities and Exchange Commission (SEC) via Form 10-k. SEC requires a publicly traded company to file an annual report 90 days after the end of the company's fiscal year to provide an overview of that business.

### Helicopters

AIA surveyed and received data from all 10 major helicopter manufacturers on their sales and deliveries.

### General Aviation

The general aviation figures are taken from the *General Aviation Statistical Databook* published by the GAMA. General aviation refers usually to the small aircraft industry in the United States. GAMA collects quarterly data from the 10 to 14 manufacturers who nearly equal a census of the general aviation sector.

### Passenger Car, Truck, Bus, and Recreational Vehicles

Ward's *Motor Vehicle Facts and Figures* is the source of these data. Ward's obtains sales data directly from manufacturers. Readers should note that automobile manufacturers have inflated sales figures in the past, but Ward's does contact companies to verify numbers that appear too high or low.

## Motorcycle

The Motorcycle Industry Council, Inc. (MIC) publishes the *Motorcycle Statistical Annual*, which is the source for these data. MIC derived the estimate for new retail motorcycle sales for each state from the *MIC Retail Sales Report*, and adjusted for total retail sales. Motorcycle company reports provided sales data. Prior to 1985, all-terrain vehicles (ATVs) were included in the motorcycle total. In 1995, the Motorcycle Industry Council revised its data for the years 1985 to present to exclude all terrain vehicles from its totals.

## Bicycle

The National Bicycle Dealers Association (NBDA) reported these data, which are based on Bicycle Manufacturers Association (BMA) information through 1996. BMA stopped reporting members' shipments in 1996. Moreover, BMA represents the largest bicycle manufacturers (Huffy, Roadmaster, and Murray), and thus the data do not reflect specialty bike makers or other manufacturers. The Bicycle Council estimated 1997 and 1998 figures in the table. According to a Bicycle Council representative, the estimates are a combination of domestic forecasts produced by a panel of industry experts and import data from monthly U.S. census databases.

## Transit

The American Public Transit Association provided these figures, which are based on information in the U.S. Department of Transportation, Federal Transit Administration (FTA), National Transit Database. These data are generally considered accurate because the FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or misinterpret data. APTA conservatively adjusts FTA data to include transit operators that do not report to the database (private, very small, and rural operators).

## Class I Rail

The data are from Railroad Facts, published annually by the Association of American Railroads

(AAR). AAR data are based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual Report*. STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Although Class I railroads encompass only 2 percent of the number of railroads in the country, they account for over 70 percent of the industry's mileage operated. Historical reliability may vary due to changes in the railroad industry, including bankruptcies, mergers, and declassification by the STB. Small data errors may also have occurred because of independent rounding in this series by the AAR.

## Amtrak

Amtrak maintains a computer database with a record of every locomotive and car it operates. For each vehicle, those records include the year built, its service status (operating or not on a daily basis), and location. These data should be considered very reliable.

## Water Transportation

U.S. Department of Transportation, Maritime Administration (MARAD), which classifies vessels as merchant based on size and type, reports these data in annual issues of its *Merchant Fleets of the World*. MARAD compiles these figures from a data service provided by Lloyd's Maritime Information Service. The parent company, Lloyd's Register (LR), collects data from several sources: its 200 offices worldwide, data transfers and agreements with other classification societies, questionnaires to shipowners and shipbuilders, feedback from government agencies, and input from port agents. According to an LR official, consistent data gathering methods have been maintained for more than 30 years but cautioned that inconsistencies may occur in groupings of ship types over time. For example, tank barges are now included in the tanker ship-type grouping rather than the barge grouping.

**TABLE 1-12. U.S. Automobile and Truck Fleets by Use**

These statistics originate from two sources. The R.L. Polk Co. provides numbers for commercial fleet vehicles from state registrations. Bobit Publishing Co. also obtains fleet vehicle sales data from automobile manufacturers. These two sources cover nearly 100 percent of fleet vehicles in the United States. Thus, the data should be very accurate.

**TABLE 1-13. Annual U.S. Motor Vehicle Production and Factory (Wholesale) Sales****TABLE 1-14. Retail New Passenger Car Sales****TABLE 1-15. New and Used Passenger Car Sales and Leases****TABLE 1-19. World Motor Vehicle Production, Selected Countries****Motor Vehicle Production, Factory Sales, and New Passenger Car Retail Sales**

Ward's Motor Vehicle Facts & Figures is the source of these data. Ward's obtains sales data directly from manufacturers. Readers should note that automobile manufacturers have inflated sales figures in the past, but Ward's does contact companies to verify numbers that appear too high or low.

**Used Passenger Car Sales and Leased Passenger Cars**

ADT Automotive Used Car Market Report is the source of these data. The *Wall Street Journal* (WSJ) is the original source of 1999 data. According to an ADT representative, publishing deadlines require ADT to use WSJ numbers until they can be replaced with National Automotive Dealers Association data. ADT Automotive's Market Analysis Department also gathers figures from CNW Marketing/Research and the R.L. Polk Co. CNW estimates used car sales volumes by collecting state title transfer data and determining if a transaction was made between private individuals or between a consumer and a franchised or

independent dealer. This estimate is evaluated by comparing total transactions with state automobile sales revenues. Polk, an additional source of data, maintains a state vehicle registration database. For 1998, the ADT representative stated that Polk's data were within 5 percentage points of CNW estimates.

**TABLE 1-16. Retail Sales of New Cars by Sector**

The U.S. Department of Commerce, Bureau of Economic Analysis, uses data from *Ward's Automotive Reports*. The sectoral break down is derived from registration data obtained from R.L. Polk. Ward's obtains sales data directly from manufacturers. Readers should note that automobile manufacturers have inflated sales figures in the past, but Ward's does contact companies to verify numbers that appear too high or low.

**TABLES 1-17 and 1-18. Period Sales, Market Shares, and Sales-Weighted Fuel Economies of New Domestic and Imported Automobiles and Light Trucks, Selected Sales Periods**

These data originate from Oak Ridge National Laboratory's (ORNL) Light-Duty MPG and Market Shares System database, which relies on information from monthly Ward's Automotive Reports. Comparisons and observations are made on sales and fuel economy trends from one model year to the next. ORNL has adopted several conventions to facilitate these comparisons, such as the use of sales-weighted average to estimate fuel economy and vehicle characteristics. For example, "sales-weighted" miles per gallon refers to a composite or average fuel economy based on the distribution of vehicle sales. ORNL's methodology for sales-weighting can be found in the Appendix of the *Highway Vehicle MPG and Market Shares Report: Model Year 1990* (the latest published report). The method was changed dramatically in 1983, and data reliability prior to that year is questionable. This information is now published annually in ORNL's *Transportation Energy Data Book*.

**TABLE 1-20. Number and Size of the U.S. Flag Merchant Fleet and Its Share of the World Fleet**

The U.S. Department of Transportation, Maritime Administration, which classifies vessels as merchant based on size and type, compiles these figures from a data service provided by Lloyd’s Maritime Information Service. The parent company, Lloyd’s Register (LR), collects data from several sources: its 200 offices worldwide, data transfers and agreements with other classification societies, questionnaires to shipowners and shipbuilders, feedback from government agencies, and input from port agents. According to an LR official, consistent data gathering methods have been maintained for more than 30 years, but cautioned that inconsistencies may occur in groupings of ship types over time. For example, tank barges are now included in the tanker ship-type grouping rather than the barge grouping.

**TABLE 1-21. U.S. Airport Runway Pavement Conditions**

These data originate from the U.S. Department of Transportation, Federal Aviation Administration (FAA), National Plan of Integrated Airport Systems (NPIAS). The NPIAS includes all commercial service airports, all reliever airports, and selected general aviation airports. It does not include more than 1,000 publicly owned public use landing areas, privately owned public use airports, and other civil landing areas not open to the general public. NPIAS airports serve 92 percent of general aviation aircraft (based on an estimated fleet of 200,000 aircraft). In 1998, the NPIAS encompassed 3,344 of the 5,357 airports with public access. Runway pavement condition is classified as follows:

- Good:* All cracks and joints are sealed.
- Fair:* Mild surface cracking, unsealed joints, and slab edge spalling.
- Poor:* Large open cracks, surface and edge spalling, vegetation growing through cracks and joints.

On a rotating basis, the FAA arranges annual inspections for about 2,000 of the approximately 4,700 public-use airports. The inspections are based on funding availability and not on statistical criteria, and nearly all runways are inspected every two years. Inspections are primarily made to collect information for pilots on airport conditions. The FAA relies on state and local agencies to perform inspections, so some inaccuracy may arise from variation in their adherence to federal guidelines regarding pavement condition reporting. In 1998, the U.S. General Accounting Office found that Pavement Condition Index information was available for about 35 percent of NPIAS airports (GAO/RCED-98-226).

**TABLE 1-22. Median Age of Automobiles and Trucks in Operation in the United States**

The R.L. Polk Co. is a private enterprise that purchases state registration data to maintain a database of operational vehicles. Its data represent a near census of registered vehicles in the United States, and the age estimate should be considered very reliable.

**TABLE 1-23. Condition of U.S. Roadways by Functional System**

U.S. Department of Transportation, Federal Highway Administration (FHWA) collects pavement condition data from each state through the Highway Performance Monitoring System. The FHWA uses two rating schemes—the Present Serviceability Rating (PSR) and the International Roughness Indicator (IRI). IRI is used to measure the condition of Interstates, other principal arterials, rural minor arterials, and other National Highway System roadways. PSR is used to measure the condition of rural major collectors and urban minor arterials and collectors. Rural minor collectors are not measured. Where IRI data are not reported for sampled sections, the PSR data are collected. Using the PSR, values range from 0.1 to 5.0, where 5.0 denotes new pavement in excellent condition and 0.1 denotes pavement in extremely poor condition. On the IRI scale how-

ever, lower values indicate smoother roads (e.g., <60 for interstate pavement in very good condition to >170 for interstate pavement in poor condition).

The IRI is an objective measure of pavement roughness developed by the World Bank. The PSR is a more subjective measure of a broader range of pavement characteristics and therefore less comparable. Prior to 1993, all pavement conditions were evaluated using PSR values. Beginning with data published in *Highway Statistics 1993*, the FHWA began a transition to the IRI, which should eventually replace the PSR. The change from PSR to IRI makes comparisons between pre-1993 pavement condition data and 1993 and later pavement condition data difficult. Thus, trend comparisons should be made with care.

FHWA indicates that the protocol of measuring pavement roughness is not followed by all states, and some did not report for all required mileage. Totals only reflect those states reporting usable or partially usable data. Column percentages may not sum to 100 and may differ slightly from percentages in source tables, which were adjusted so that they would add to 100. FHWA believes that the IRI data are of “reasonably good quality.”

**TABLE 1-24. Condition of U.S. Bridges**

These figures are from the U. S. Department of Transportation, Federal Highway Administration (FHWA), National Bridge Inventory Database. State highway agencies are required to maintain a bridge inspection program and inspect most bridges on public roadways at a minimum of every two years. With FHWA approval, certain bridges may be inspected less frequently. A complete file of all bridges is collected and maintained, representing a very reliable assessment of bridge conditions. However, some inaccuracy may be attributable to variations in state inspector’s adherence to the National Bridge Inspection Standards.

**TABLE 1-25. Average Age of Urban Transit Vehicles**

These figures are based on information in the U.S. Department of Transportation, Federal

Transit Administration (FTA), National Transit Database. Section 15 of the Federal Transit Act requires federally funded transit agencies to provide detailed financial and operating data, including vehicle inventories. Transit operators that do not report to FTA are those that do not receive federal funding, typically private, small, and rural operators. The data are generally considered accurate because FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or may misinterpret certain data definitions.

**TABLE 1-26. Class I Railroad Locomotive Fleet by Year Built**

The data are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). Figures reported by the AAR are based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual Report*. STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although Class I railroads encompass only 2 percent of the number of railroads in the country, they account for over 70 percent of the industry’s mileage.

**TABLE 1-27. Age and Availability of Amtrak Locomotive and Car Fleets**

Amtrak maintains a computer database with a record of every locomotive and car it operates. For each vehicle those records include the year built, its service status (operating or not on a daily basis), and location. These data should be considered very reliable.

**TABLE 1-28. U.S. Flag Vessels by Type and Age**

The data are from the U.S. Army Corps of Engineers (USACE), *Waterborne Transportation Lines of the United States* (WTLUS), annual issues. The WTLUS database contains information on vessel operators and characteristics and descriptions for all domestic vessel operations. Data are collected by the USACE's Navigation Data Center, primarily through a survey of vessel operating companies. More than 3,000 surveys are sent to these companies and response rates are typically above 90 percent. However, a USACE official did report that less than 10 percent of the total number of companies operating inland vessel fleets either did not receive and/or did not respond to the annual survey.

**TABLE 1-29. U.S. Vehicle-Miles****TABLE 1-30. Roadway Vehicle-Miles Traveled (VMT) and VMT per Lane-Mile by Functional Class****TABLE 1-31. U.S. Passenger-Miles**

### **Air Carrier, Certificated, Domestic, All Services**

The U.S. Department of Transportation (USDOT), the Bureau of Transportation Statistics, Office of Airline Information, reports aircraft revenue-miles and passenger-miles in its publication *Air Traffic Statistics*. These numbers are based on 100-percent reporting of passengers and trip length by large certificated air carriers. Minor errors arise from nonreporting but amount to less than 1 percent of all air carrier passenger-miles. The figures do not include data for all airlines, such as most scheduled commuter airlines and all nonscheduled commuter airlines. These, if added, may raise total air passenger-miles by about 5 percent.

### **General Aviation**

Passenger-mile numbers for 1975 to present are calculated by adjusting the Interstate Commerce Commission's 1974 figure for air passenger-miles by the percentage change in annual hours flown by

general aviation aircraft as published in the USDOT, Federal Aviation Administration (FAA), *FAA Statistical Handbook of Aviation*. Numbers in the handbook are based on the General Aviation and Air Taxi Survey (GAATA). In 1993, the GAATA stopped including commuter aircraft. Commuter-miles collected before 1993 by the GAATA were, according to one FAA official, woefully underreported. Therefore, problems with the estimate of general aviation aircraft include: a break in the series between 1992 and 1993, a possible outdated factor used to calculate passenger-miles, and the classification of commuter operations.

### **Highway**

Highway vehicle-miles of travel (vmt) are estimated using data from the Highway Performance Monitoring System (HPMS), a database maintained by FHWA that contains information on highway characteristics supplied by individual states. Annual vmt by highway functional system is calculated as the product of the annual average daily traffic (AADT) along each highway section, the centerline length of each highway section, and the number of days in the year. Also, expansion factors are used for roadways that are sampled rather than continuously monitored. Vmt by vehicle type is estimated using vehicle share estimates supplied by states.

FHWA has established methods for collecting, coding, and reporting HPMS data in two manuals: *Traffic Monitoring Guide* (TMG) and *Highway Performance Monitoring System Field Manual*. The prescribed sampling process for collecting highway volume data, which is used to estimate AADT, is based on statistical methods. However, in practice, several factors affect the ultimate quality of the data. FHWA discusses many of these issues in their annual *Highway Statistics* report and other publications. However, BTS is not aware of any study or report that has statistically quantified the accuracy of vmt estimates. Some of the primary issues related to data quality are noted here.

1. The sampling procedures suggested in the TMG and HPMS *Field Manual* are designed to produce traffic volume estimates with an aver-



age precision level of 80-percent confidence with a 10-percent allowable error at the state level. FHWA provides additional guidance to states through annual workshops and other avenues to help them follow these procedures as closely as possible. However, the actual data quality and consistency of HPMS information are dependent on the programs, actions, and maintenance of sound databases by numerous data collectors, suppliers, and analysts at the state, metropolitan, and other local area levels. Not all states follow the recommended sampling, counting, and estimating procedures contained in the *Traffic Monitoring Guide*, and the exact degree to which the states follow these guidelines overall is unknown. However, FHWA believes that most states generally follow the guidelines.

2. Estimates for higher level roadway systems are more accurate than those for lower level ones, since traffic volumes on higher level roadways are sampled at a higher rate. The TMG recommends that traffic counts be collected for all Interstate and principal arterial sections on a three-year cycle. Under this scheme, about one-third of the traffic counts for these roadway sections in a given year are actually measured, while volumes on the remainder are factored to represent present growth. Although some States collect data at all traffic count locations every year, most use some variation of the TMG data collection guidelines. Volumes on urban and rural minor arterials, rural major collectors, and urban collectors are collected using a sampling procedure. States are not required to report volumes for rural/urban local systems and rural minor collectors, though most do so. However, the methods used to estimate travel on these roadways vary from state to state since there are no standard guidelines for calculating travel on these roadways.

3. Vmt estimates by vehicle type are less accurate than are estimates for total motor vehicle vmt for several reasons: 1) vehicle classification equipment can frequently misclassify vehicles (see B.A. Harvey et al, *Accuracy of Traffic Monitoring Equipment*, GDOT 9210, (Georgia Tech Research Institute: 1995)); 2)

vehicle shares are often determined by methods or by special studies that are not directly compatible with HPMS data definitions and/or purposes, and observed local-level vehicle classification counts are difficult to apply on a statewide basis; and 3) vehicle type definitions can vary among states.

4. Vmt estimates for combination trucks in HPMS differ from survey-based estimates from the Truck Inventory and Use Survey (TIUS), as much as 50 percent for some categories of combination trucks. Much of this discrepancy appears to be due to differences in truck classification definitions and biases introduced by data collection practices. See R.D. Mingo et al. 1995. *Transportation Research Record*, No. 1511 (Washington, DC: National Academy Press), pp. 42-46.

5. FHWA adjusts questionable data using a variety of standard techniques and professional judgement. For example, national average temporal adjustment factors developed from HPMS and other national highway monitoring programs are applied to State data, when necessary, to compensate for temporal deficiencies in sampling practices. Also, in estimating vmt by vehicle type, FHWA employs an iterative process to reconcile vmt, fuel economy (miles per gallon), fuel consumption, and vehicle registration estimates. Fuel consumption, total vmt by highway functional class, and registrations by vehicle group are used as control totals. This process limits the size of errors and ensures data consistency.

6. Passenger-miles of travel (pmt) are calculated by multiplying vmt estimates by vehicle loading (or occupancy) factors from various sources, such as the Nationwide Personal Transportation Survey conducted by FHWA and TIUS. Thus, pmt data are subject to the same accuracy issues as vmt, along with uncertainties associated with estimating vehicle loading factors.

## Transit

The American Public Transit Association (APTA) figures are based on information in USDOT, Federal Transit Administration (FTA),

National Transit Database. Transit data are generally considered accurate because FTA reviews and validates information submitted by individual transit agencies. However, reliability may vary because some transit agencies cannot obtain accurate information or may misinterpret data. APTA adjusts the FTA data to include transit operators that do not report to the FTA database (private, very small, and rural operators).

### **Class I Rail (vehicle-miles)**

Data are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). AAR data are based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual Report* required of Class I railroads. STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although Class I railroads represent only 2 percent of railroads in the country, they account for over 70 percent of the industry's mileage.

### **Intercity Train**

The AAR passenger-miles number is based on an almost 100-percent count of tickets and, therefore, is considered accurate.

**TABLE 1-33. Long-Distance Travel in the United States by Selected Trip Characteristics: 1995**

**TABLE 1-34. Long-Distance Travel in the United States by Selected Traveler Characteristics: 1995**

The data presented in these tables are estimates derived from the 1995 American Travel Survey (ATS) conducted for the U.S. Department of Transportation, Bureau of Transportation Statis-

tics. The survey's estimation procedure inflates unweighted sample results to independent estimates of the total population of the United States. Values for missing data are estimated through imputation procedures.

Since ATS estimates come from a sample, they are subject to two possible types of error: nonsampling and sampling. Sources of nonsampling errors include inability to obtain information about all sample cases, errors made in data collection and processing, errors made in estimating values for missing data, and undercoverage.

The accuracy of an estimate depends on both types of error, but the full extent of the nonsampling error is unknown. Consequently, the user should be particularly careful when interpreting results based on a relatively small number of cases or on small differences between estimates.

Standard errors for ATS estimates that indicate the magnitude of sampling error as well as complete documentation of the source and reliability of the data may be obtained from detailed ATS reports. Because of methodological differences, users should use caution when comparing these data with data from other sources.

**TABLE 1-35. U.S. Air Carrier Departures, Enplaned Revenue Passengers, and Enplaned Revenue Tons**

The *Airport Activity Statistics of Certificated Air Carriers* (AAS) is the source of these data. Published annually by the U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information (OAI), the AAS presents traffic statistics for all scheduled and nonscheduled service by large certificated U.S. air carriers for each airport served within the 50 states, the District of Columbia, and other U.S. areas designated by the Federal Aviation Administration. The publication draws its data from the T-100 and T-3 databases maintained by OAI. These data are based on a 100-percent reporting of enplanements, departures, and tonnage information by large certificated U.S. air carriers via BTS Form 41.

Prior to 1993, the AAS included all scheduled and some nonscheduled enplanements for certifi-

cated air carriers but did not include enplanements for air carriers offering charter service only. Prior to 1990, the freight category was divided into both freight and express shipments and the mail category was divided into U.S. mail (priority and non-priority) and foreign mail. Beginning in 1990, only aggregate numbers were reported for freight and mail.

Air traffic hubs are designated as geographical areas based on the percentage of total passengers enplaned in the area. A hub may have more than one airport. This definition of hub should not be confused with the definition used by airlines in describing their “hub-and-spoke” route structures.

**TABLE 1-36. Passengers Boarded at the Top 50 U.S. Airports**

The *Airport Activity Statistics of Certificated Air Carriers* (AAS), is the source of these data. Data for 1998 are from the U.S. Department of Transportation (USDOT), Federal Aviation Administration’s *Statistical Handbook of Aviation*. Published by USDOT, Bureau of Transportation Statistics, Office of Airline Information (OAI), the AAS presents traffic statistics for all scheduled and nonscheduled service by large certificated U.S. air carriers for each airport served within the 50 states, the District of Columbia, and other U.S. areas designated by the Federal Aviation Administration. The publication draws its data from the T-100 and T-3 databases maintained by OAI. These data are based on a 100-percent reporting of enplanements, departures, and tonnage information by large certificated U.S. air carriers via BTS Form 41.

Prior to 1993, the AAS included all scheduled and some nonscheduled enplanements for certificated air carriers but did not include enplanements for air carriers offering charter service only. Prior to 1990, the freight category was divided into both freight and express shipments and the mail category was divided into U.S. mail (priority and non-priority) and foreign mail. Beginning in 1990, only aggregate numbers were reported for freight and mail.

**TABLE 1-37. Air Passenger Travel Arrivals in the United States from Selected Foreign Countries**

**TABLE 1-38. Air Passenger Travel Departures from the United States to Selected Foreign Countries**

The International Trade Administration in the U. S. Department of Commerce publishes these data, which are based on information collected from 100,000 international visitors.

**TABLE 1-41. U.S. Ton-Miles of Freight**

### Air Carrier

*Air Carrier Traffic Statistics*, published by the U.S. Department of Transportation, Bureau of Transportation Statistics (BTS), Office of Airline Information (OAI), is the source of these data. Large certificated U.S. air carriers report domestic freight activities to OAI via BTS Form 41. The information reported in the table represents transportation of freight (excluding passenger baggage), U.S. and foreign mail, and express mail within the 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. It also covers transborder traffic to Canada and Mexico by U.S. carriers. The data does not include information on small certificated air carriers, which represent less than 5 percent of freight ton-miles.

### Intercity Truck

The data are estimates from *Transportation in America*, published by the Eno Transportation Foundation, Inc. (Eno). Eno’s estimates of intercity truck ton-miles are based on historic data from the former Interstate Commerce Commission (ICC), estimates from the American Trucking Association, and other sources. Eno supplements its estimates by using additional information on vehicle-miles of truck travel published in *Highway Statistics* by the Federal Highway Administration. Users should note that truck estimates in the tables do not include local truck movements.

## Class I Rail

The data are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). AAR data are based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB). The data represent all revenue freight activities of the Class I railroads and are not based on information from the Rail Waybill Sample. The STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although the Class I railroads represented only 2 percent of the number of railroads in the country, they account for over 90 percent of the rail industry's freight revenues.

## Domestic Water Transport

The data are from *Waterborne Commerce of the United States*, published by the U.S. Army Corps of Engineers (USACE). All vessel operators of record report their domestic waterborne traffic movements to USACE via ENG Forms 3925 and 3925b. Cargo movements are reported according to points of loading and unloading. Certain cargo movements are excluded: 1) cargo carried on general ferries, 2) coal and petroleum products loaded from shore facilities directly into vessels for fuel use, 3) military cargo moved in U.S. Department of Defense vessels, and 4) cargo weighing less than 100 tons moved on government equipment. USACE calculates ton-miles by multiplying the cargo's tonnage by the distance between the points of loading and unloading.

## Oil Pipeline

The data for 1960, 1965, and 1970 are from *Transportation in America*, published by the Eno Transportation Foundation, Inc., and the data for 1975 to 1998 are from *Shifts in Petroleum Transportation*, by the Association of Oil Pipe Lines (AOPL). Eno's data are based on information from the former Interstate Commerce

Commission's *Transport Economics*. Common carrier oil pipelines reported all freight activities to the ICC.

AOPL obtains barrel-miles from the Federal Energy Regulatory Commission (FERC), which requires petroleum shippers to report annual shipments. AOPL then converts barrel-miles to ton-miles using conversion figures in the American Petroleum Institute's (API's) *Basic Petroleum Data Book*. Since 16 percent of pipeline shipments are intrastate and not subject to FERC reporting requirements, AOPL makes adjustments to FERC data.

**TABLE 1-42. Average Length of Haul: Domestic Freight and Passenger Modes**

## Freight

### Air Carrier and Truck

The Eno Transportation Foundation, Inc. estimated these figures.

## Class I Rail

The data are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). AAR data are based on 100-percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the R1 Annual Report required of Class I railroads. The STB defined Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although Class I railroads represent only 2 percent of railroads in the country, they account for over 70 percent of the industry's mileage.

## Water

The data are from *Waterborne Commerce of the United States*, published by the U.S. Army Corps of Engineers (USACE). All vessel operators

of record report their domestic waterborne traffic movements to USACE via ENG Forms 3925 and 3925b. Cargo movements are reported according to points of loading and unloading. Certain cargo movements are excluded: 1) cargo carried on general ferries, 2) coal and petroleum products loaded from shore facilities directly into vessels for fuel use, 3) military cargo moved in U.S. Department of Defense vessels, and 4) cargo weighing less than 100 tons moved on government equipment. USACE calculates ton-miles by multiplying the cargo's tonnage by the distance between points of loading and unloading.

### Oil Pipeline

The Eno Transportation Foundation, Inc., provided these figures, which are estimates based on U.S. Department of Energy and Association of Oil Pipe Lines reports. Figures are derived by dividing estimated pipeline ton-miles by estimated crude and petroleum products tonnage.

### Passenger

#### Air Carrier

The U.S. Department of Transportation (USDOT), the Bureau of Transportation Statistics, Office of Airline Information, reports average trip length in its publication *Air Traffic Statistics*. These numbers are based on 100-percent reporting of passengers and trip length by large certificated air carriers via BTS Form 41. The figures do not include data for all airlines, such as most scheduled commuter airlines and all nonscheduled commuter airlines.

#### Bus

The Eno Transportation Foundation, Inc. estimated these figures based on Class I carrier passenger data and vehicle-miles data from *Highway Statistics*, an annually published report of the USDOT, Federal Highway Administration.

#### Commuter Rail

The American Public Transit Association (APTA) provided these data, which are based on the USDOT, Federal Transit Administration's (FTA's), National Transit Database. Transit data

are generally accurate because the FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or may misinterpret data. APTA conservatively adjusts FTA data to include transit operators that do not report to the database (private, very small, and rural operators).

### Intercity/Amtrak

The Statistical Appendix to the *Amtrak Annual Report* is the source of these data. Amtrak data are based on 100 percent of issued tickets, and thus should be accurate.

### TABLE 1-43. Top U.S. Foreign Trade Freight Gateways by Value of Shipments: 1998

The value of U.S. air, maritime, and land imports and exports are captured from administrative documents required by the U.S. Departments of Commerce and Treasury. In 1990, the United States entered into a Memorandum of Understanding with Canada concerning the exchange of import data. As a consequence, each country is using the other's import data to replace its own export data. U.S. international merchandise trade statistics, therefore, are no longer derived exclusively from the administrative records of the Departments of Commerce and Treasury, but from Revenue Canada. Import value is for U.S. general imports, customs value basis. Export value is FAS (free along ship) and represents the value of exports at the U.S. port of export, including the transaction price and inland freight, insurance, and other charges. Trade levels reflect the mode of transportation as a shipment entered or exited a U.S. Customs port.

Truck, rail pipeline, mail, and miscellaneous modes are included in the total for land modes. Data present trade activity between the United States, Puerto Rico, and the U.S. Virgin Islands and Canada and Mexico. These statistics do not include traffic between Guam, Wake Island, and America Samoa and Canada and Mexico. These statistics also exclude imports that are valued at less than \$1,250 and for exports that are valued at less than \$2,500.

**TABLE 1-46. U.S. Waterborne Freight**

The data are from *Waterborne Commerce of the United States*, published by the U.S. Army Corps of Engineers (USACE). All vessel operators of record report their domestic waterborne traffic movements to USACE via ENG Forms 3925 and 3925b. Cargo movements are reported according to points of loading and unloading. Certain cargo movements are excluded: 1) cargo carried on general ferries, 2) coal and petroleum products loaded from shore facilities directly into vessels for fuel use, 3) military cargo moved in U.S. Department of Defense vessels, and 4) cargo weighing less than 100 tons moved on government equipment. USACE calculates ton-miles by multiplying the cargo's tonnage by the distance between points of loading and unloading.

Foreign waterborne statistics are derived from Census Bureau and U.S. Customs data, which excludes traffic between Guam, Wake Island, and American Samoa and any other foreign country, and imports and exports used by U.S. Armed Forces abroad. Individual vessel movements with origins and destinations at U.S. ports, traveling via the Panama Canal are considered domestic traffic.

**TABLE 1-47. Tonnage of Top 50 U.S. Water Ports, Ranked by Total Tons**

Data on the weight of U.S. maritime imports and exports are captured from administrative documents required by the U.S. Departments of Commerce and Treasury. In 1990, the United States entered into a Memorandum of Understanding with Canada concerning the exchange of import data. As a consequence, each country is using the other's import data to replace its own export data. The United States' merchandise trade statistics, therefore, are no longer derived exclusively from U.S. government administrative records, but from Revenue Canada. Maritime weight data are initially processed and edited by the Foreign Trade Division, U.S. Census Bureau (Census) as part of the overall edits and quality checks performed on all U.S. international merchandise trade data. After Census processing, the U.S. Army Corps of Engineers (USACE) and

the Maritime Administration (MARAD) perform additional maritime-specific processing and quality edits on maritime-related data elements, including the weight of maritime imports and exports. The USACE and MARAD began performing this function in October 1998 after the Foreign Waterborne Trade data program was transferred from the Census Bureau. Prior to October 1998, the USACE historically performed additional specialized edits at the port level, including reassignment of some tonnage data to the actual waterborne port rather than the reported U.S. Customs port.

**TABLE 1-43. Modal Shares of Freight Shipments within the United States by Domestic Establishments: 1993 and 1997****TABLE 1-49. Value, Tons, and Ton- Miles of Freight Shipments within the United States by Domestic Establishment, 1997****TABLE 1-52. U.S. Hazardous Materials Shipments by Mode of Transportation, 1997****TABLE 1-53. U.S. Hazardous Materials Shipments by Hazard Class, 1997**

These data are collected via the 1997 Commodity Flow Survey (CFS) undertaken through a partnership between the U.S. Department of Commerce, Census Bureau (Census), and the U.S. Department of Transportation, Bureau of Transportation Statistics. For the 1997 CFS, Census conducted a sample of 100,000 domestic establishments randomly selected from a universe of about 800,000 multiestablishment companies in the mining, manufacturing, wholesale trade, and selected retail industries. It excluded establishments classified as farms, forestry, fisheries, governments, construction, transportation, foreign, services, and most retail.

### Reliability of the Estimates

An estimate based on a sample survey potentially contains two types of errors—sampling and nonsampling. Sampling errors occur because the estimate is based on a sample, not on the entire

universe. Nonsampling errors can be attributed to many sources in the collection and processing of the data and occur in all data, not just those from a sample survey. The accuracy of a survey result is affected jointly by sampling and nonsampling errors.

### Sampling Variability

Because the estimates are derived from a sample of the survey population, results are not expected to agree with those that might be obtained from a 100-percent census using the same enumeration procedure. However, because each establishment in the Standard Statistical Establishment List had a known probability of being selected for sampling, estimating the sampling variability of the estimates is possible. The standard error of the estimate is a measure of the variability among the values of the estimate computed from all possible samples of the same size and design. Thus, it is a measure of the precision with which an estimate from a particular sample approximates the results of a complete enumeration. The coefficient of variation is the standard error of the estimate divided by the value being estimated. It is expressed as a percent. Note that measures of sampling variability, such as the standard error or coefficient of variation, are estimated from the sample and are also subject to sampling variability. Standard errors and coefficients of variation for CFS data presented in this report are given in Appendix B of the 1997 Economic Census report, and are available online [www.census.gov/econ/wwwse0700.html](http://www.census.gov/econ/wwwse0700.html).

### Nonsampling Errors

In the CFS, as in other surveys, nonsampling errors can be attributed to many sources, including 1) nonresponse; 2) response errors; 3) differences in the interpretation of questions; 4) mistakes in coding or recoding the data; and 5) other errors of collection, response, coverage, and estimation.

A potentially large source of nonsampling error is due to nonresponse, which is defined as the inability to obtain all intended measurements or responses from selected establishments. Nonresponse is corrected by imputation.

### TABLE 1-50. Value of U.S. Land Exports to and Imports from Canada and Mexico by Mode

The Transborder Surface Freight Data (TSFD) is derived from official U.S. international merchandise import and export data. (For a description of U.S. merchandise trade statistics, see [www.census.gov/foreign-trade/www/index.html](http://www.census.gov/foreign-trade/www/index.html).) As of December 1995, about 96 percent of the value of all U.S. imports has been collected electronically by the Automated Broker Interface System. About 55 percent of the value of all U.S. exports is collected electronically through the U.S./Canada Data Exchange and the Automated Export Reporting Program. The balance is collected from administrative records required by the U.S. Departments of Commerce and Treasury.

The TSFD incorporates all data, by surface mode, on shipments entering or exiting the United States from or to Canada or Mexico. Prior to January 1997, this dataset also included transshipments—shipments entering or exiting the United States by way of U.S. Customs ports on the northern or southern borders even when the actual origin or final destination of the goods was other than Canada or Mexico. (In other U.S. Bureau of the Census trade statistics, transshipments through Canada and Mexico are credited to the true country of origin or final destination.) To make this dataset more comparable to other U.S. Census Bureau trade statistics, detailed information on transshipments has been removed. The TSFD presents a summary of transshipments by country, direction of trade, and mode of transportation. Shipments that neither originate nor terminate in the United States (i.e., intransits) are beyond the scope of this dataset because they are not considered U.S. international trade shipments.

In general, the reliability of U.S. foreign trade statistics is very good. Users should be aware that trade data fields (e.g., value and commodity classification) are typically more rigorously reviewed than transportation data fields (e.g., the mode of transportation and port of entry/exit). Users should also be aware that the use of foreign trade data to describe physical transportation flows may not be accurate. For example, this dataset provides surface transportation information for indi-

vidual U.S. Customs districts and ports on the northern and southern borders. However, because of filing procedures for trade documents, these ports may or may not record where goods physically cross the border. This is because the information filer may choose to file trade documents at one port while shipments actually enter or exit at another port. The TSFD, however, is the best publicly available approximation for analyzing transborder transportation flows.

Since the dataset was introduced in April 1993, it has gone through several refinements and improvements. When improbabilities and inconsistencies were found in the dataset, extensive analytical reviews were conducted and improvements made. However, accuracy varies by direction of trade and individual field. For example, import data are generally more accurate than export data. This is primarily because the U.S. Customs Bureau uses import documents for enforcement purposes while it performs no similar function for exports. For additional information on TSFD, the reader is referred to the U.S. Department of Transportation, Bureau of Transportation Statistics Internet site at [www.bts.gov/transborder](http://www.bts.gov/transborder).

**TABLE 1-51. Crude Oil and Petroleum Products Transported in the United States by Mode**

### Pipelines

The Association of Oil Pipelines (AOPL) obtains barrel-miles from the Federal Energy Regulatory Commission (FERC), which requires petroleum shippers to report annual shipments. AOPL then converts barrel-miles to ton-miles using conversion figures in the American Petroleum Institute's (API's) *Basic Petroleum Data Book*. Since 16 percent of pipeline shipments are intrastate and not subject to FERC reporting requirements, AOPL makes adjustments to FERC data to include intrastate shipments. AOPL also conducts periodic studies to estimate intrastate shipments.

### Water Carriers

Data are from *Waterborne Commerce of the United States*, published by the U.S. Army Corps

of Engineers (USACE). All vessel operators of record report domestic freight and tonnage information to USACE via ENG Forms 3925 and 3925b. Cargo movements are reported according to points of loading and unloading. Certain cargo movements are excluded: 1) cargo carried on general ferries, 2) coal and petroleum products loaded from shore facilities directly into vessels for fuel use, 3) military cargo moved in U.S. Department of Defense vessels, and 4) cargo weighing less than 100 tons moved on government equipment. USACE calculates ton-miles by multiplying the cargo's tonnage by the distance between the points of loading and unloading.

### Motor Carriers

AOPL estimates ton-miles by multiplying tons by the average length of haul. For crude, the tonnage of the prior year is projected by using a growth rate established by data from the U.S. Department of Energy, Energy Information Administration's *Petroleum Supply Annual*, vol. 1, table 37. For products, the same calculation is made but with a growth rate estimated by the American Trucking Association in *Financial and Operating Statistics, Class I and II, Motor Carriers*, Summary table VI-B. Average length of haul is determined from the prior six years of data for ton-miles and tonnage of crude and petroleum products moved by motor carriers.

### Railroad

AOPL calculates ton-miles by multiplying tonnage by average length of haul. Tonnage data for crude and products comes from the Association of American Railroad's *Freight Commodity Statistics*, U.S. Class I Railroads. The U.S. Department of Transportation, Federal Railroad Commission provides the average length of haul for crude and products in its *Carload Way Bill Statistics*.

**TABLE 1-54. Worldwide Commercial Space Launches**

The U.S. Department of Transportation, Federal Aviation Administration, Associate Administrator for Commercial Space Transportation (AST) licenses and regulates U.S. commer-



cial space launches as authorized by the Commercial Space Launch Act of 1984 and Executive Order 12465. Every commercial space launch must be approved and monitored by AST. Thus, data reliability is high.

**TABLE 1-55. Passengers Denied Boarding by the Largest U.S. Air Carriers**

**TABLE 1-56. Mishandled-Baggage Reports Filed by Passengers with the Largest U.S. Air Carriers**

**TABLE 1-57. Flight Operations Arriving On Time for the Largest U.S. Air Carriers**

These numbers are based on data filed with the U.S. Department of Transportation on a monthly basis by the largest U.S. air carriers – those that have at least one percent of total domestic scheduled-service passenger revenues. Data cover non-stop scheduled service flights between points within the United States (including territories). The largest U.S. carriers account for more than 90 percent of domestic operating revenues. They include Alaska Airlines, America West Airlines, American Airlines, Continental Airlines, Delta Air Lines, Northwest Airlines, Trans World Airlines, Southwest Airlines, United Airlines, and US Airways. However, there are other carriers offering domestic scheduled passenger service that are not required to report. In some cases, major airlines sell tickets for flights that are actually operated by a smaller airline that is not subject to the reporting requirement.

**TABLE 1-58. U.S. Air Carrier Delays Greater than 15 Minutes by Cause**

The source of these data, the U.S. Department of Transportation (USDOT), Federal Aviation Administration (FAA), counts a flight as delayed if it departed or arrived more than 15 minutes after its scheduled gate departure and arrival times. FAA calculates delayed departures based on the difference between the time a pilot requests FAA clearance to taxi and the time an aircraft's wheels lift off the runway, minus the airport's standard

unimpeded taxi-out time. Users should note that taxi-out time varies by airport due to differences in configurations. The cause of delay is also recorded, e.g., weather, terminal volume, closed runways, etc.

USDOT guidance defines departure as the time the aircraft parking brake is released and gate arrival as the time the brake is set. According to the USDOT's Office of the Inspector General (OIG), FAA's omission of part of a plane's ground movement compromises the data's validity. A recent OIG report noted that the FAA tracks ground time only after a pilot requests clearance and fails to track a plane's time in the ramp area. OIG found that ramp time comprised 28.7 percent to 40.5 percent of the average taxi-out time at the three major New York area airports (OIG Audit Report CR-2000-112), and would not be counted as an FAA delay.

### Reliability

Several data collection changes complicate comparisons over time. For example, FAA modified its method for calculating volume-related delays that resulted in a 17 percent drop in such delays. Decreases in volume-related delays from 1998 to 1999 totaled less than one percent. Moreover, prior to 1999, USDOT did not provide a clear definition of what a departure was. An OIG Audit (CE-1999-054) report noted that air carriers used four different departure events: 1) rolling of aircraft wheels; 2) release of parking brake; 3) closure of passenger and/or cargo doors; and 4) a combination of door closures and release of the parking break. The same report also noted errors in the reporting of departure times by the air carriers.

Data are now manually entered in FAA's Operations Network (OSPNET) database, and reporting errors may arise and decrease reliability. The FAA monitors data quality assurance by spot checking the reported delay data and requesting that discrepancies be reviewed by the responsible facility. According to an OIG Audit (CR-2000-112), however, mistakes are not reliably corrected and many air traffic controllers suggested that delays are underreported sometimes by as much as 30 percent.

**TABLE 1-59. Major U.S. Air Carrier Delays, Cancellations, and Diversions**

A second data source for air-carrier delay is the USDOT, Bureau of Transportation Statistics, Office of Airline Information (OAI). This information originates from the Airline Service Quality Performance data. These figures are collected from the largest airlines—those that have at least one percent or more of total domestic scheduled service passenger revenues. Delays are categorized by phase of flight (i.e., gate-hold, taxi-out, airborne, or taxi-in delays). These data differ from FAA's OSPNET information due to differences in definition of delay.

While the FAA tracks delays on the taxiway, runway, and in the air, BTS tracks delays at the departure and arrival gates. OAI calculates delays as the difference between scheduled and actual gate departure. If a flight leaves the gate within 15 minutes of its scheduled time, then OAI would record it as departed on-time even if it sat for several hours on the ramp or runway, in which case the delay would be accounted for as a late arrival.

**TABLE 1-60. Annual Person-Hours of Delay Per Eligible Drive****TABLE 1-61. Roadway Congestion Index****TABLE 1-62. Congestion Index and Cost Values**

The Texas Transportation Institute's (TTI) *Urban Roadway Congestion Annual Report* provided figures for tables 1-54 through 56. TTI relies on data from the U.S. Department of Transportation, Federal Highway Administration, Highway Performance Monitoring System database (HPMS). TTI utilizes these data as inputs to its congestion estimation model. Detailed documentation for the TTI model and estimations can be found at this website <http://mobility.tamu.edu/study/index.stm>.

### Structure, Assumptions, and Parameters

Urban roadway congestion levels are estimated using a formula measuring traffic density. Average travel volume per lane on freeways and principal

arterial streets are estimated using area wide estimates of vehicle-miles of travel (vmt) and lane miles of roadway. The resulting ratios are combined using the amount of travel on each portion of the system so that the combined index measures conditions on the freeway and principal arterial street systems. Values greater than one are indicative of undesirable congestion levels. Readers seeking the algorithm for the congestion index should examine this website <http://mobility.tamu.edu/study/numbers.stm>.

Annual person-hours of delay results from the multiplication of daily vehicle-hours of incident and recurring delay times 250 working days per year times 1.25 persons per vehicle. Two types of costs are incurred due to congestion: time delay and fuel consumption. Delay costs are the product of passenger vehicle hours of delay times \$12.00 per hour person time value times 1.25 occupants per vehicle. Fuel costs are calculated for passenger and commercial vehicles from the multiplication of peak period congestion speeds, the average fuel economy, fuel costs, and vehicle-hours of delay.

In previous reports, the TTI methodology assumed that 45 percent of all traffic, regardless of the urban location, occurred in congested conditions. TTI indicated that this assumption overestimated travel in congested periods. Thus, their 1999 estimates now vary by urban area anywhere from 21 percent to 50 percent of travel that occurs in congestion. TTI's model structure applies to two types of roads: freeways and principal arterial streets. The model derives estimates of vehicle traffic per lane and traffic speed for an entire urban area. Based on variation in these amounts, travel is then classified under 5 categories: uncongested, moderately congested, heavily congested, severely congested, and extremely congested (a new category in 1999). The threshold between uncongested and congested was changed in 1999. Previous editions classified congested travel when areawide traffic levels reached 13,000 vehicles per lane per day on highways and 5,000 vehicles per lane per day on principal arterial streets. These thresholds were raised in the latest report to 14,000 and 5,500 vehicles per lane per day respectively. Comparisons across time will be questionable due to these changes. For instance, TTI applied the new methodology to 1996 data that resulted in

lower congestion levels. Readers should refer to the TTI Internet site for more detailed algorithms and estimation procedures at [http://mobility.tamu.edu/estimating\\_mobility](http://mobility.tamu.edu/estimating_mobility).

TTI reviews and adjusts the data used in their models. State and local officials also review the TTI data and estimations. Some of the limitations acknowledged in the TTI report include the macroscopic character of the index. Thus, it does not account for local variations in travel patterns that may affect travel times. The index also does not account for local improvements, such as ramp metering or travel speed advantages obtained with transit or carpool lanes.

**TABLE 1-63. Amtrak On-Time Performance Trends and Hours of Delay by Cause**

Amtrak determines on-time performance through its computer system maintained at the National Operations Center (NOPS) in Wilmington, Delaware. If a train is delayed, a call is made to the NOPS for recordkeeping. These data can be supplemented with computer entries made for locomotive or car malfunctions that cause delays. These data should be considered reliable.

Chapter 2 Safety

AIR DATA

TABLE 2-1. Transportation Fatalities by Mode

TABLE 2-2. Injured Persons by Transportation Mode

TABLE 2-3. Transportation Accidents by Mode

TABLE 2-4. Distribution of Transportation Fatalities by Mode

TABLE 2-7. Transportation-Related Occupational Fatalities

TABLE 2-9. U.S. Air Carrier Safety Data

TABLE 2-10. U.S. Commuter Air Carrier Safety Data

TABLE 2-11. U.S. Air Carrier Fatal Accidents by First Phase of Operation

TABLE 2-12. U.S. Commuter Air Carrier Fatal Accidents by First Phase of Operation

TABLE 2-13. U.S. On-Demand Air Taxi Safety Data

TABLE 2-14. U.S. General Aviation Safety Data

National Transportation Safety Board investigators perform onsite and offsite investigations of all accidents involving U.S. registered air carriers operating under 14 CFR 121, 14 CFR 135, and general aviation U.S. Department of Transportation (USDOT), Federal Aviation Administration (FAA) regulations. The investigators compile information on fatalities and injuries for all accidents. The counts for fatalities and serious injuries are expected to be extremely accurate. (See glossary for serious injury definition.)

Exposure data (aircraft-miles, aircraft-hours, and aircraft-departures) are obtained from the FAA, which in turn gets some of its exposure data from the USDOT, Bureau of Transportation Statistics, Office of Airline Information (OAI) and other exposure data from its own General Aviation and Air Taxi Activity and Avionics (GAATAA) Survey. The OAI data represent 100 percent

reporting by airlines. Tables that include air carriers (14 CFR 121, scheduled and nonscheduled service) and commuter air carriers (14 CFR 135, scheduled service only) use OAI exposure data. Tables that include on-demand air taxi (14 CFR 135, nonscheduled service) and general aviation use GAATAA Survey results. For information about the GAATAA Survey, please refer to the chapter 1 data accuracy statement for table 1-9.

The coefficients of variation for aircraft-hours vary by year, but are usually in the 9 to 10 percent range for on-demand air taxi and are approximately 2 percent for general aviation.

TABLE 2-15. Number of Pilot-Reported Near Midair Collisions by Degree of Hazard

Near Midair Collision reports are provided voluntarily by air carriers, general aviation companies, and the military, and this information is added to the Near Midair Collisions System database. Factors that may influence whether or not a near midair collision is reported include the pilot's or other crew member's perception of whether a reportable near midair collision occurred, which in turn can depend on factors such as visibility conditions; the reporter's flying experience; or the size of the aircraft involved. A reportable incident is one in which an aircraft is within 500 feet of another aircraft and a possibility of collision existed.

TABLE 2-16. Airline Passenger Screening Results by Type of Weapons Detected, Persons Arrested, and Bomb Threats Received

Federal Aviation Regulations (FARs) mandate that passenger screening be performed by each air carrier required to implement an approved security program. The USDOT, Federal Aviation Administration, monitors the records of passenger screening in accordance with FAR, and oversees compliance with the carriers' security programs through, for example, scheduled and unscheduled inspections. FAR requires the reporting of information on bomb threats.

## HIGHWAY DATA

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**TABLE 2-1. Transportation Fatalities by Mode**

**TABLE 2-2. Transportation Injuries by Mode**

**TABLE 2-3. Transportation Accidents by Mode**

**TABLE 2-4. Distribution of Transportation Fatalities by Mode**

**TABLE 2-5. Highway-Rail Grade-Crossing Safety Data and Property Damage**

**TABLE 2-7. Transportation-Related Occupational Fatalities**

**TABLE 2-17. Motor Vehicle Safety Data**

**TABLE 2-18. Motor Vehicle Fatalities, Vehicle-Miles, and Associated Rates by Highway Functional System**

**TABLE 2-19. Occupant Fatalities by Vehicle Type and Nonoccupant Fatalities**

**TABLE 2-21. Passenger Car Occupant Safety Data**

**TABLE 2-22. Motorcycle Ride Safety Data**

**TABLE 2-23. Truck Occupant Safety Data**

**TABLE 2-24. Bus Occupant Safety Data**

**TABLE 2-25. Fatalities by Highest Blood Alcohol Concentration in Highway Crashes**

**TABLE 2-27. Motor Vehicle Fatal Crashes by Day of Week, Time of Day, and Weather and Light Conditions**

**TABLE 2-28. Motor Vehicle Fatal Crashes by Posted Speed Limit**

**TABLE 2-20. Occupant and Nonmotorist Fatalities in Crashes by Number of Vehicles and Alcohol Involvement**

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### Fatalities

Highway fatality data come from the Fatality Analysis Reporting System (FARS), which is compiled by trained FARS analysts at USDOT, National Highway Traffic Safety Administration (NHTSA) regional offices. Data are gathered from

a census of police accident reports (PARs), state vehicle registration files, state drivers licensing files, state highway department data, vital statistics, death certificates, coroner/medical examiner reports, hospital medical reports, and emergency medical service reports. A separate form is completed for each fatal crash. Blood alcohol concentration (BAC) is estimated when not known. Statistical procedures used for unknown data in FARS can be found in the NHTSA report *A Method for Estimating Posterior BAC Distributions for Persons Involved in Fatal Traffic Accidents*, DOT HS 807 094 (Washington, DC: July 1986).

Data are collected from relevant state agencies and electronically submitted for inclusion in the FARS database on a continuous basis. Cross-verification of PARs with death certificates ensures that undercounting is rare. Moreover, when data are entered, they are checked automatically for acceptable range values and consistency, enabling quick corrections when necessary. Several programs continually monitor the data for completeness and accuracy. Periodically, sample cases are analyzed for accuracy and consistency.

Note that the FARS data do not include motor vehicle fatalities on nonpublic roads. However, previous NHTSA analysis found that these fatalities account for 2 percent or fewer of the total motor vehicle fatalities per year. (See glossary for highway fatality definition.)

### Injuries and Crashes

NHTSA's General Estimates System (GES) data are a nationally representative sample of police-reported crashes that contributed to an injury or fatality or resulted in property damage, and involved at least one motor vehicle traveling on a trafficway. Trained GES data collectors randomly sample PARs and forward copies to a central contractor for coding into a standard GES system format. Documents such as police diagrams or supporting text provided by the officers may be further reviewed to complete a data entry.

NHTSA suggests that about half of motor vehicle crashes in the United States are not reported to police and that the majority of these unreported crashes involve minor property damage and no significant personal injury. A NHTSA study of

injuries from motor vehicle crashes estimated the total count of nonfatal injuries at over 5 million compared with the GES's estimate of 3.2 million in 1998. (See glossary for highway crash and injury definitions.)

(See U.S. Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts*, 1998, DOT HS 808 983 (Washington, DC: October 1999), appendices B and C for further information on the GES, including a table of standard errors applicable to GES data.)

### **TABLE 2-29. Safety Belt and Motorcycle Helmet Use**

The National Occupant Protection Use Survey (NOPUS), conducted in 1994, 1996, and 1998 by the U.S. Department of Transportation, National Highway Traffic Safety Administration is the source for these data.

In 1994 and 1996, NOPUS consisted of three separate studies: 1) the Moving Traffic Study, which provides information on overall shoulder belt use, 2) the Controlled Intersection Study, which provides more detailed information about shoulder belt use by type of vehicle, characteristics of the belt users and child restraint use, and 3) the Shopping Center Study, which provides information on rear-seat belt use and shoulder belt misuse. In 1998, the Shopping Center Study was dropped from the survey. The Controlled Intersection Study includes the collection of license plate information to link seat belt use to vehicle type. As the results of the Controlled Intersection Study for 1998 were not available prior to publication, only the Moving Traffic Study data were used in this table.

In 1998, the NOPUS separated pickups from the light truck category, thereby creating three categories of passenger vehicles: passenger cars, pickup trucks, and other passenger vehicles. Other passenger vehicles include vans, minivans, and sport utility vehicles. In this table, 1998 data for pickup trucks and other vehicles are combined into the light truck category to allow comparison to data from the earlier surveys.

In 1994, operators and riders wearing any type of helmet were counted as helmeted. In 1996 and 1998, motorcycle helmets that meet USDOT standards are counted as valid protection, whereas those that do not meet USDOT standards were treated as if the operator/rider were not wearing a helmet.

Data collection from the moving traffic study was conducted at over 3,800 sites across the country. Shoulder belt use was obtained for drivers and right-front passengers only. Three observers (two observers in 1994 and 1996) were stationed for 30 minutes at interstate/highway exit ramps, controlled (intersections with stop signs or traffic signals), and uncontrolled intersections. Every day of the week and all daylight hours (8 a.m. to 6 p.m.) were covered in each survey. Commercial and emergency vehicles were excluded.

NOPUS was designed as a multistage probability sample to ensure that the results would represent occupant protection use in the country. In the first stage, counties were grouped by region (northeast, midwest, south, west), level of urbanization (metropolitan or not), and level of belt use (high, medium, or low). Fifty counties or groups of counties were selected based on the vehicle miles of travel in those locations. In the next stage, roadways were selected from two categories: major roads and local roads. Finally, approximately 4,000 intersections or exit ramps were chosen on these roadways. Of the originally selected sites, some were found to be ineligible during mapping and data collection, and at some sites no vehicles were observed. In 1998, a total of 199,412 passenger cars, 135,505 light trucks (of which 76,004 were other vehicles and 59,501 were pickup trucks), and 1,444 motorcycles were observed.

Each reported estimate has been statistically weighted according to the sample design. Two kinds of error can be attributed to all survey research: sampling and nonsampling. A measure, called the standard error, is used to indicate the magnitude of sampling error. The source information provides two standard errors along with each estimate. Nonsampling errors could include problems such as vehicles not counted, incorrect determination of restraint use, and data entry mistakes, among others.

**TABLE 2-30. Estimated Number of Lives Saved by Use of Restraints**

The U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA) uses data obtained from the Fatality Analysis Reporting System to calculate the number of lives saved by the use of restraints. The methodology used is outlined in a NHTSA report, *Research Note, Estimating Lives Saved by Restraint Use in Potentially Fatal Crashes* (Washington, DC: June 1995). The general approach is to adjust the observed number of fatalities by a determined effectiveness rate for each type of restraint. This equates to subtracting the actual fatalities from the potential fatalities to determine the number of lives saved. This method is more accurate than earlier estimation methods since all calculations are derived from NHTSA's count of fatalities in which restraints were used. Reported restraint use is believed to be accurate for fatalities.

The key to NHTSA's calculations is the effectiveness estimate for preventing fatalities for each type of restraint. With the exception of an adjustment in the effectiveness estimate for front outboard air bag-only restraint use in passenger cars (NHTSA, *Fourth Report to Congress, Effectiveness of Occupant Protection Systems and Their Use*, Washington, DC, May 1999), a list of effectiveness estimates can be found in a NHTSA report, *Estimating Alcohol Involvement in Fatal Crashes in Light of Increases in Restraint Use*, published in March 1998. This report also includes additional references describing the determination of these effectiveness estimates.

## TRANSIT DATA

**TABLE 2-1. Transportation Fatalities by Mode****TABLE 2-2. Transportation Injuries by Mode****TABLE 2-3. Transportation Accidents by Mode****TABLE 2-4. Distribution of Transportation Fatalities by Mode****TABLE 2-31. Transit Safety and Property Damage Data****TABLE 2-32. Transit Safety Data by Mode for All Reported Accidents****TABLE 2-33. Transit Safety Data by Mode for All Reported Incidents****TABLE 2-34. Reports of Violent Crime, Property Crime, and Arrests by Transit Mode**

The data for this report are obtained from the U.S. Department of Transportation, Federal Transit Administration's (FTA's) National Transit Database (NTD) Reporting System. Transit agencies are required to file an NTD report at regular intervals if they are recipients of Urbanized Area Formula Funds. In 1998, 575 agencies reported to the NTD. Of that total, 60 transit agencies received exemptions from detailed reporting because they operated 9 or fewer vehicles, and 6 were deleted because their data were incomplete. Thus, 509 individual reporters were included in the NTD, accounting for 90 to 95 percent of passenger-miles traveled on transit. Of the transit agencies reporting, 56.2 percent contract for some or all of their transportation from private or public companies or organizations.

Transit operators report fatalities, injuries, accidents, incidents, and property damage in excess of \$1,000. Electronic reporting has recently been implemented for the NTD. Certification from a company's Chief Executive Officer must accompany all NTD reports along with an independent auditor's statement. Upon receipt, an NTD report is reviewed and outstanding items noted in writing to the agency that submitted the form. (See glossary for transit fatality, injury, and accident definitions.)

Four major categories of transit safety are collected: 1) collisions, 2) derailments/buses going off the road, 3) personal casualties, and 4) fires. These major categories are divided into subcategories. The collisions category comprises collisions with vehicles, objects, and people (except suicides). Of the four major categories, only the first two are included in the definition of transit accidents adopted in this report (see glossary). Understanding this definition of accident is relevant to understanding how double counting is removed in the grand total of U.S. transportation

fatalities and injuries. (See cross modal comments in box 2-1.)

Transit data submitted to the NTD are generally considered accurate because the FTA reviews and validates information submitted by individual transit agencies. However, reliability may vary because some transit agencies cannot obtain accurate information or misinterpret data.

## Security

FTA collects security data from transit agencies serving urbanized areas of over 200,000 in population, using Form 405, and manages it in the National Transit Database (NTD). The reporting of security data follows the FBI *Uniform Crime Reporting Handbook* (Washington, DC: 1984) and is divided into two categories: 1) Reported Offenses, including violent and property crime, and 2) Arrests, consisting of less serious crimes. The figures for violent and property crime are based on records of calls for service, complaints, and/or investigations. They do not reflect the findings of a court, coroner, jury, or decision of a prosecutor. Security data were first reported in 1995 and were not compiled for earlier years.

In 1998, the number of agencies reporting to this database was 575. Of that, 60 transit agencies received exemptions from detailed reporting because they operated nine or fewer vehicles, and six were deleted because their data were incomplete. Thus, 509 individual reporters are included in the full database in 1998. Of the transit agencies reporting, 56.2 percent contract for some or all of their transportation from private or public companies or organizations.

## RAILROAD DATA

**TABLE 2-1. Transportation Fatalities by Mode**

**TABLE 2-2. Transportation Injuries by Mode**

**TABLE 2-3. Transportation Accidents by Mode**

**TABLE 2-4. Distribution of Transportation Fatalities by Mode**

**TABLE 2-5. Highway-Rail Grade-Crossing Safety Data and Property Damage**

Box 2-1.

### Cross-Modal Comparisons

Caution must be exercised in comparing fatalities (and injuries) across modes because different definitions for reportable events are used among the modes. In particular, rail and transit facilities and injuries include deaths and injuries that are not, strictly speaking, caused by transportation accidents, but are caused by such events as a fall on a transit station escalator; or for railroad employees, a fire in a workshop. Similar fatalities for the air and highway modes (death at airports not caused by moving aircraft, or fatalities from accidents in automobile repair shops) are not counted towards the totals for these modes.

Total fatalities (injuries) in the tables are less than the sum of the modal totals because some deaths (injuries) are reported and counted in more than one mode. To avoid double counting, adjustments have been made to fatality totals (see table 2-4).

### TABLE 2-7. Transportation-Related Occupational Fatalities

**TABLE 2-35. Railroad and Grade-Crossing Fatalities by Victim Class**

**TABLE 2-36. Railroad and Grade-Crossing Injured Persons by Victim Class**

**TABLE 2-37. Train Fatalities, Injuries, and Accidents by Type of Accident**

**TABLE 2-38. Railroad Passenger Safety Data**

**TABLE 2-39. Railroad System Safety and Property Damage Data**

**TABLE 2-40. Fatalities and Injuries of On-Duty Railroad Employees**

Railroads are required to file a report for each train accident resulting in property damage in excess of \$6,600, each highway-rail accident, and each incident involving the operation of a railroad resulting in a fatality or a reportable injury. (See glossary for reportable injury, train accident and incident, and nontrain incident definitions.)

Reporting requirements, which are fixed in law, are very broad and encompass events not strictly related to transportation. For example, if a passenger falls on a staircase and breaks a leg in



the station while going to a train, the injury would be reported and appear in the data as a rail injury.

**WATERBORNE TRANSPORTATION DATA**

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- TABLE 2-1. Transportation Fatalities by Mode
  - TABLE 2-2. Transportation Injuries by Mode
  - TABLE 2-3. Transportation Accidents by Mode
  - TABLE 2-4. Distribution of Transportation Fatalities by Mode
  - TABLE 2-7. Transportation-Related Occupational Fatalities
  - TABLE 2-41. Waterborne Transportation Safety Data and Property Damage Related to Vessel Casualties
  - TABLE 2-42. Waterborne Transportation Safety Data Not Related to Vessel Casualties
- 

U.S. waterborne fatality and injury data are based on reports required by CFR Part 4.05-10. This code requires that the owner, agent, master, operator, or person in charge file a written report of any marine casualty or accident within five days of the accident. Reports must be delivered to Investigative Officers (IOs) at a U.S. Coast Guard Marine Safety Office or Marine Inspection Office at the U.S. Department of Transportation, who use these reports as guides to investigate the marine casualty or accident. The IO ensures that all the entries on the forms are filled out and errors are corrected. Regulations require IO notification of marine casualties for certain circumstances, including loss of life; injuries that require medical treatment beyond first aid; and, for individuals engaged or employed onboard a vessel in commercial service, injuries that render a person unfit to perform routine duties.

Incidents requiring an investigation include death, injury resulting in substantial impairment, and other incidents determined important to promoting the safety of life or property or to protect the marine environment. These incidents are

investigated in accordance with procedures set forth in the regulations. Furthermore, the Federal Water Pollution Control Act mandates that certain incidents be reported to the U.S. Coast Guard. The reports are entered into the Marine Safety Information System, which is later analyzed and transferred to the Marine Safety Management System maintained in Washington, DC.

**RECREATIONAL BOATING DATA**

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- TABLE 2-1. Transportation Fatalities by Mode
  - TABLE 2-2. Transportation Injuries by Mode
  - TABLE 2-3. Transportation Accidents by Mode
  - TABLE 2-4. Distribution of Transportation Fatalities by Mode
  - TABLE 2-43. Recreational Boating Safety, Alcohol Involvement, and Property Damage Data
  - TABLE 2-44. Personal Watercraft Safety Data
  - TABLE 2-45. U.S. Coast Guard Search and Rescue Statistics, Fiscal Years
- 

Operators of boats involved in an accident resulting in 1) a fatality, 2) an injury requiring medical treatment beyond first aid, 3) damage to the vessel or other property greater than \$500 or complete loss of vessel, or 4) the disappearance of a person from the vessel under circumstances indicating death or injury are required to file a report with the U.S. Coast Guard. If a person dies within 24 hours of the occurrence, requires medical treatment beyond first aid, or disappears from the vessel, reports must be made within 48 hours of the occurrence. In cases involving only damage to the vessel and/or property, reports are to be submitted within 10 days of the occurrence. Although there is no quantitative estimate of the response rate, there may be considerable underreporting, especially of nonfatal accidents, because of the difficulty of enforcing the requirement and because boat operators may not always be aware of the law.

**NATURAL GAS AND LIQUID  
PIPELINE DATA**

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**TABLE 2-1. Transportation Fatalities by Mode**

**TABLE 2-2. Transportation Injuries by Mode**

**TABLE 2-3. Transportation Accidents by Mode**

**TABLE 2-4. Distribution of Transportation  
Fatalities by Mode**

**TABLE 2-46. Hazardous Liquid and Natural  
Gas Pipeline Safety and Property Damage  
Data**

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U.S. fatality and injury data for natural gas pipelines are based on reports filed with the U.S. Department of Transportation (USDOT), Office of Pipeline Safety (OPS). Accidents must be reported as soon as possible, but no later than 30 days after discovery. Reports are sent to the Information Systems Manager at the OPS. Possible sources of error include a release going undetected; even if subsequently detected and reported, it may not be possible to accurately reconstruct the accident. Property damage figures are estimates. (See glossary for gas and liquid pipeline fatality data and injury definitions.)

**TABLE 2-6. Hazardous Materials Safety Data  
and Property Damage Data**

Incidents resulting in certain unintentional releases of hazardous materials must be reported

under 49 CFR 171.16. Each carrier must submit a report to the U.S. Department of Transportation, Research and Special Programs Administration (RSPA) within 30 days of the incident, including information on the mode of transportation involved, results of the incident, and a narrative description of the accident. These reports are made available on the incident database within 60 days of receipt.

Fatalities and injuries are counted only if they are directly due to a hazardous material. For example, a truck operator killed by impact forces during a motor vehicle crash would not be counted as a hazardous-material fatality. RSPA verifies all reported fatalities and injuries by telephone with the carrier submitting the report.

Possible sources of error include a release going undetected; even if subsequently detected and reported, it may not be possible to accurately reconstruct the accident. Although RSPA acknowledges that there is some level of underreporting, it believes that the underreporting is limited to small, nonserious incidents. As incident severity increases, it is more likely that the incident will come to RSPA's attention and will ultimately be reported. Additionally, the reporting requirements were extended to intrastate highway carriers on October 1, 1998, and the response rate from this new group is expected to increase over time. Property damage figures are estimates determined by the carrier prior to the 30-day reporting deadline and are generally not subsequently updated. Property damage figures, therefore, may underestimate actual damages.

## Chapter 3 *Transportation and the Economy*

**TABLE 3-1a & 3-1b. U.S. Gross Domestic Product Attributed to For-Hire Transportation Services (Current and chained 1996 dollars)**

**TABLE 3-2a & 3-2b. U.S. Gross Domestic Product Attributed to Transportation-Related Final Demand (Current and chained 1996 dollars)**

**TABLE 3-3a & 3.3b. U.S. Gross Domestic Demand Attributed to Transportation-Related Final Demand (Current and chained 1996 dollars)**

**TABLE 3-4a & 3-4b. Contributions to Gross Domestic Product: Selected Industries (Current and chained 1996 dollars)**

**TABLE 3-5. Gross Domestic Product by Major Social Function**

Tables 3-1 through 3-5 present data on transportation's contributions to the economy through consumption (or the money spent on transportation activity). The *Survey of Current Business* (SCB) published by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). The SCB is a monthly journal that contains estimates of U.S. economic activity, including industry contributions to the Gross Domestic Product (GDP). GDP is defined as the net value of the output of goods and services produced by labor and property located in the United States. BEA constructs two complementary measures of GDP—one based on income and the other on expenditures (product). Together, they represent the National Income and Product Accounts (NIPA), our nation's principle framework for macroeconomic estimates. The product side results from the addition of labor, capital, and taxes for producing output. Consumption derives from household, business, and government expenditures and net foreign purchases.

Table 3-3 presents transportation's economic impact in a different form, Gross Domestic Demand (GDD). Also derived from the national accounts, GDD is the sum of personal consumption, gross private domestic investment, and gov-

ernment purchases. GDD includes imports, but excludes exports, thus counting only what is consumed, purchased, or invested in the United States.

### **GDP Methodology**

The 1960 through 1985 data in table 3-1 are from the November 1993 issue of the SCB. The 1990 through 1991 data and 1992 through 1996 data are from an August 1996 and November 1997 SCB issue respectively. The October 1999 issue introduced a revised methodology for GDP estimates (Yuskavage 1996). This section describes BEA's methodology for estimating transportation's share of GDP.

BEA's current-dollar estimates of GDP by industry rely on several sources, including the Bureau of Labor Statistics (BLS), the Health Care Financing Administration, and the Internal Revenue Service (IRS). Some of the tables in this chapter report chained-dollar figures. BEA derived chained dollars by using the Fisher Ideal Quantity Index to calculate changes between adjacent years (Parker and Triplett 1996; Landerfeld and Parker 1997). Annual changes are then chained to form a time series that incorporates the effects of relative price and output composition changes. Please refer to page 142 of the August 1996 issue of the *Survey of Current Business* for the mathematical formulas (Yuskavage 1996). This method produced separate estimates of gross output and intermediate inputs for a sector's GDP calculation. BEA updated the reference year for the chained-dollar estimates from 1992 to 1996.

Transportation GDP in chained dollars was estimated using the double-deflation method, which relies on a chain-type quantity index formula, and requires gross output and intermediate input information. Principal source data for the transportation categories include: 1) operating revenues of air carriers and Federal Express from the U.S. Department of Transportation and public sources (air); 2) operating revenues for Class I motor carriers from historical records of the Interstate Commerce Commission and Census Bureau annual surveys (trucking and warehousing); 3) BEA personal consumption expenditures

(PCE), BLS, and trade sources (local and interurban passenger transit); 4) operating revenues for Class I railroads and Amtrak (rail); and 5) other trade sources (pipelines). Data sources for water were not provided (Yuskavage, 1996).

Table 3-1 reported current dollar estimates from various SCB issues. BEA derived the 1991 data and subsequent years in four steps:

1. BEA's benchmark input-output (I-O) tables produced input compositions for 1977, 1982, and 1987.
2. BEA estimated 1978 through 1981 and 1983 through 1986 input compositions by interpolating the 1977, 1982, and 1987 figures.
3. BEA estimates the 1977 through 1987 imported and domestically imported shares of each detailed input.
4. BEA estimates the 1988 through 1994 input compositions based on the 1987 figures and the Economic Censuses of 1992.

For intermediate input estimations, BEA deflates each of the current-dollar inputs. (BEA deflates import and domestic production separately.) For deflation, quantities are approximated by real values (expressed at present with 1996 as the base period) that are calculated by dividing the current-dollar value of the component by its price index. BEA develops estimates for import prices with data from a variety of sources, but primarily from the BLS import price series

### Reliability and Accuracy

BEA views GDP as a reliable measure of output because of the source data underlying the estimates. The following reliability comments are based on the Valliant (1993) SCB article and Ritter (2000). GDP data originate from three types of sources. The foundational data come first from the economic censuses conducted every five years. These approach complete enumerations of sectoral activity in state and local governments, manufacturing, services, retail trade, wholesale trade, construction, transportation, communications and utilities, mining, finance, insurance, and real estate. Annual estimates form the second tier of GDP data and emanate from sources such as IRS

tax returns and smaller surveys of establishments. The Annual Retail Trade Survey, for instance, forms one of the major components of the annual estimates. The U.S. Census Bureau collects sales and end-of-year inventory data from about 22,000 retail firms totaling \$2 trillion of the \$8.8 trillion GDP amount. While considered reliable by many economists, sampling variability may introduce errors into these annual estimates. Moreover, the Census Bureau imputes (substitutes estimates for missing or clearly incorrect data) about 11 percent of reported national annual retail sales because of accounting inconsistencies or raw survey data errors. The third component of the GDP flows from quarterly estimates.

In the October 1993 SCB, Valliant described the reliability and accuracy of the quarterly estimates of GDP, providing insights into the pre-1985 data in terms of dispersion and bias. BEA followed a schedule that produced three successive "current" estimates; advanced, preliminary, and final. BEA analysts developed a dispersion and bias measure based on the difference between these three estimates.

Dispersion is the average of the absolute values of the revisions, or, the difference between  $P$ , representing the percentage change in the current estimates, and  $L$  representing the percentage change in the latest available estimates, divided by  $n$ , representing the number of quarterly changes. Bias is the average of the revisions. According to the October 1993 SCB, dispersion averaged 1.6 percent from 1958 to 63 and dropped to 1.1 percent for 1968 to 1972. BEA stated that these declines in dispersion correspond with more accurate initial and final estimates subsequent to the late 1950s. For years after 1973 until 1991, the BEA concluded that more accurate source data for preliminary and final estimates did not improve reliability by much. BEA also determined that bias was not large enough from 1978 to 1991 to be significant under normality assumptions at the five-percent confidence level. Overall, for the period beginning in 1978 and covering the 1985 data from table 3-1, the BEA concluded there was no evidence of reliability increases. BEA also questioned its own estimating procedures and, in particular, the use of disparate sources of data, which may explain why reliability levels have not increased.

The NIPA framework also undergoes major updates referred to as comprehensive, or benchmark revisions. Eleven of these have been completed including one in 1996 and most recently on October 28, 1999 that provided the data for tables 3-1 through 3-5. The major change encompassed a definitional change reflecting our evolving economic system. Software became a business investment rather than just a "purchased input," or the equivalent of raw material. Unless the company increased the price of its product to cover software purchases, no impact registered in the GDP. With this benchmark revision, the Census Bureau increased the 1996 estimate by \$115 billion, or 1.5 percent--the amount of software investments made in that year. Another change involved the Census Bureau's interpretation of the value of "unpriced" banking services such as ATM (automatic teller machine) contributions to an establishment's productivity. Previously, banking service productivity relied only on an index constructed from labor input. Economists argued that this ignored productivity gains from technological improvements such as ATMs and electronic banking. The BLS developed a productivity based instead of bank transactions, and this was used in the 1999 revision. For more detail, readers should refer to Moulton and Seskin (1999).

### **Sources of Error for GDP Estimates**

The GDP estimates can contain several kinds of error. One source of error arises from estimates based on preliminary or incomplete tabulations of source data or BEA judgment in the absence of data. Errors may also arise because of sampling errors and biases in monthly, quarterly, annual, or periodic tabulations. Another source of potential error may arise when data are seasonally adjusted. Readers should refer to the October 1993 SCB issue for more detail (Young 1993).

### **NIPA and Transportation-Related Final Demand**

For table 3-2, transportation-related final demand (TRFD) is from NIPA reported in the SCB. It represents the sum of all consumer and government expenditures for transportation purposes, plus the value of goods and services purchased by business as investment for transporta-

tion purposes. Since TRFD includes only expenditures on the final products of the economy, it is comparable to GDP and provides a measure of transportation's importance from a consumption perspective.

NIPA tables report the composition of production and the distribution of incomes earned in production. The totals of these produce a GDP estimate that should theoretically be equal, but there is always a difference referred to as the "statistical discrepancy." NIPA is based on four sub-accounts of national economic activity. These include 1) the personal income and outlay account, 2) the gross savings and investment account, 3) the government receipts and expenditures account, and 4) the foreign transactions account.

Personal Consumption Expenditures (PCE) for transportation include 1) road motor vehicles, such as new and used automobiles, and motorcycles; 2) motor vehicle parts, such as tires, tubes, accessories; 3) motor fuels and lubricants; and 3) transportation services, such as repair, greasing, washing, parking, storage, rental, leasing, tolls, insurance, and purchased local and intercity transportation services. Motor vehicles used primarily for recreation, boats, noncommercial trailers, and aircraft are excluded.

Gross private domestic fixed investment in transportation includes private purchases of transportation structures and equipment. Transportation structures include railroads and petroleum pipelines. Transportation equipment consists of automobiles, trucks, buses, truck trailers, aircraft, ships and boats, and railroad equipment.

Goods and services that are counted as part of transportation-related exports include 1) civilian aircraft, engines, and parts; 2) road motor vehicles, engines, and parts; 3) passenger fares, including receipts of U.S. air and ocean/cruise carriers for transporting non-U.S. residents between the United States and foreign countries or between two foreign points; and 4) other transportation. The total for road motor vehicles, engines and parts excludes boats, aircraft, and noncommercial trailers. Other transportation includes 1) the freight revenues of U.S.-operated ocean, air, and other carriers (e.g., rail, pipeline, and Great Lakes

shipping) for international transport of U.S. exports and for transporting foreign freight between foreign points; 2) port expenditure receipts (representing payments for goods and services purchased in the United States by foreign-operated carriers); and 3) receipts of U.S. owners from foreign operators for the charter of vessels and rental of freight cars and containers.

Goods and services that are counted as part of transportation-related imports include 1) civilian aircraft, engines, and parts; 2) road motor vehicles, engines, and parts; 3) passenger fares, including payments to foreign air and ocean/cruise carriers for the transportation of U.S. residents between the United States and foreign countries or between two foreign points; and 4) other transportation. The total for road motor vehicle, engines and parts excludes boats, aircraft, and non-commercial trailers. Other transportation includes 1) freight revenues of foreign-operated ocean, air, and other carriers (e.g., rail, pipeline, and Great Lakes shipping) for international transport of U.S. imports and for the transportation of foreign freight between foreign points; 2) port expenditure receipts (representing payments for goods and services purchased in foreign countries by U.S.-operated carriers); and 3) payments to foreign owners from U.S. operators for the charter of vessels and rental of freight cars and containers.

Transportation-related government purchases include federal, state, and local purchases of transportation services, and government expenditures on transportation-related structures and equipment. Federal, state, and local purchases represent the sum of consumption expenditures and gross inventory. Defense-related purchases include expenditures on the transportation of materials (care and movement of goods by water, rail, truck, and air); the rental of trucks and other transportation equipment and warehousing fees; and travel of persons (care and movement of Department of Defense military civilian employees), including tickets for all modes of travel, per diem, taxi fares, automobile rental, and mileage allowances for privately owned vehicles.

### Further References

This data source and accuracy statement is based on several papers that have appeared in the

SCB. Data users who desire more methodological detail can refer to the list of references at the end of this chapter.

### TABLE 3-6. National Transportation and Economic Trends

The *Statistical Abstract of the United States* published by the U.S. Department of Commerce, Census Bureau, is the source of the population data. The *Current Population Reports* are the source of the *Abstract's* data that are collected through the *Current Population Survey* (CPS). This is a monthly survey administered by the Census Bureau of a scientifically selected sample representative of the noninstitutional civilian population in 754 areas covering every state and the District of Columbia. Like other surveys, the CPS is subject to sampling error. Readers should note that estimates based on the CPS may not agree with census counts because different procedures are used. Changes in the CPS also mean that annual comparisons must be made with caution. For instance, in 1994, the CPS methodology was dramatically changed, and the estimates began to incorporate 1990 census population controls, adjusted for the estimated undercount.

Industrial production data come from the Industrial Production Index, produced by the Board of Governors of the Federal Reserve System and published in the *Economic Report of the President*. For annual figures, individual industrial production (IP) indexes are constructed from a variety of sources, including the quinquennial Censuses of Manufactures and Mineral Industries; the Annual Survey of Manufactures, prepared by the Census Bureau; the Minerals Yearbook, prepared by the U.S. Department of the Interior; and publications of the U.S. Department of Energy. The Federal Reserve Board (FRB) uses these data in a modeling framework to produce estimates of industrial production. Below are brief discussions on three major sources for the IP indexes; the survey of manufactures, the census of manufactures, and the electric utility survey.

### Annual Survey of Manufacturers

The Census Bureau conducts a mail survey of approximately 55,000 manufactures with three

different sample strata. The sampling frame is based on previously surveyed firms and is updated annually based partially on IRS administrative records and other sources. Large manufactures (shipments > \$500 million, and > 250 employees), some computer manufacturing firms, and all remaining firms with at least 250 employees are selected. Establishments with employment generally ranging from 20 to 250 employees are sampled with a probability proportional to a composite measure of establishment size. Approximately 5,000 of the smallest firms (5 to 20 employees) are also sampled and receive a shorter survey instrument. Additional information on the survey, readers should refer to [www.census.gov/econ/www/ma0300.html](http://www.census.gov/econ/www/ma0300.html).

### Census of Manufacturers

The Census of Manufactures collects data through mail surveys from approximately 237,000 multiunit and single-unit firms with a minimum payroll figure. This census is supplemented by IRS administrative data from over 142,000 firms not contacted by mail. For additional information on the census, readers should refer to [www.census.gov/econ/www/ma0100.html](http://www.census.gov/econ/www/ma0100.html).

### Electric Utility Survey

Since 1971, the FRB has conducted the *Monthly Survey of Industrial Electricity Use* based on responses from utilities and manufacturing and mining firms that are cogenerators. This survey is the basis for estimates of the amount of electricity power used by 120 industrial sectors. More than 40 industrial production series estimates are based on data from this survey and compose 28 percent of the Industrial Production Index in 1994 value-added proportions.

Survey responses are voluntary and are gathered from a panel of 175 utilities and 186 cogenerating companies with a monthly response rate near 95 percent. In 1992, an additional 71 new cogenerators joined the panel. This resulted, according to an FRB statistical analysis, in a decrease of the standard deviation of errors for electricity growth rates from 3.0 to 1.9 percentage points. Overall, the estimates for total power use produce a standard error of about 0.5 percentage

points. The panel accounts for approximately 73 percent of industrial electric power use in the United States.

The *Survey of Current Business*, published by the U.S. Department of Commerce, Bureau of Economic Analysis, is the source of GDP estimates. Readers should refer to the source and accuracy statement for tables 3-1 through 3-5 for information on GDP estimates.

### TABLE 3-7. Passenger and Freight Transportation Expenditures

Detailed information from the source was not available at the time of publication. Readers should contact the Eno Transportation Foundation, Inc. directly for information about methodologies and reliability.

### TABLE 3-8. Sales Price of Transportation Fuel to End-Users

The U.S. Department of Energy, Energy Information Administration's (EIA's) *Annual Energy Review 1999*, tables 5.20 and 5.21, provided price data, except for railroad fuel. Pre-1981 data were reported by the EIA from Bureau of Labor Statistics reports. Beginning in 1983, the EIA administered a series of surveys to collect data on petroleum prices, market distribution, supply, and demand. The EIA-782 series encompasses three surveys: 1) Form EIA-782A, Refiners'/Gas Plant Operators' Monthly Petroleum Product Sales Report; 2) Form EIA-782B, Resellers'/Retailers' Monthly Petroleum Product Sales Reports; and 3) Form EIA-782C, Monthly Report of Prime Supplier Sales of Petroleum Products Sold for Local Consumption.

EIA developed a method for comparing data from the new surveys with older information gathered by various methods. As a result, a number of adjustment factors were developed and used to "backcast" price estimates. Readers who require a more detailed description of this methodology should refer to EIA's petroleum data publications web page ([www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html)) and the explanatory notes section.

Changes in sample elements or collection methods may affect data continuity. Two regulatory changes affected data collection in October 1993. The Clean Air Act Amendments of 1990 required that oxygenated gasoline be sold in the winter months in ozone nonattainment areas. Thus, the EIA-782 forms were modified to collect information on fuels divided among conventional, oxygenated, and reformulated categories. Second, requirements for the production and selling of low-sulfur diesel were required and necessitated the separation of diesel fuel into high- and low-sulfur categories. Moreover, surveys prior to October 1993 did not include propane. The EIA followed several different sampling designs during two periods in the 1980s and thus, there may be some price estimate discontinuity for periods between December 1983 and January 1984 as well as between August and September of 1988.

### Data Collection

The 782 series occurs on a monthly schedule via mail. The 782A and 782C surveys reflect a census of about 115 and 190 firms, respectively. The 782B samples about 2,000 firms. The EIA first stratifies by sales volume for the form 782B survey to ensure that dealers with 5 percent or more of the market are captured with certainty. The remaining elements of the frame were assigned a probability of selection to form a 2,200 firm survey. These "noncertainty" companies were post-stratified by geographic area and type of sales category.

### Data Reliability

EIA has studied its sampling effects on reliability and determined that the sample size of 2,000 should yield a less than 1-percent price coefficient of variation in its estimates. Errors can arise because of nonresponse, but an EIA official indicated that the response rates for the 1997-1999 782A, B, and C surveys averaged 95 percent, 86 percent, and 96 percent, respectively. Because survey data invariably contain incomplete data (because of reporting errors or nonresponse), EIA estimates or "imputes" missing data. Readers requiring imputation algorithms should refer to the 782 series explanatory notes referred to above.

### TABLE 3-9. Price Trend of Gasoline v. Other Consumer Goods and Services

Data in this table were reproduced from the American Petroleum Institute's (API) *Basic Petroleum Data Book*. API noted that data reported prior to 1981 was obtained from Platt's *Oil Price Handbook* and *Oilmanac*. Platt's is part of Standard and Poor's, and an independent third party organization that tracks the petroleum industry. Platt's reported the retail price of gasoline based on telephone interviews with gas stations in 55 cities. More detailed historical information on their data collection methods could not be ascertained and the data's reliability is uncertain. API reported the Bureau of Labor Statistics (BLS) as its data source for 1981 to 1998 retail gasoline prices. The remainder of this section discusses the BLS Consumer Price Index (CPI) data collection and estimation methods used to derive the average retail price of gasoline.

BLS uses the CPI as a measure of average price changes paid by urban consumers for a fixed basket of goods and services. BLS estimates the CPI with a survey-based approach. Survey results define a categorization of goods and services, a representative sample of items to track, and weights according to the consumption of an average consumer during a base period.

### Sample Design

BLS relies on two sampling frames for their CPI estimates. One represents the universe of retail outlets from which households may purchase defined groups of commodities and services including gasoline. A second represents households across urban areas. Moreover, the household frame is based on an "urban-consumer" population and consists of households in Metropolitan Statistical Areas (MSA's) and in urban places with more than 2,500 inhabitants. This "all urban" CPI (CPI-U) provides the estimates for retail gasoline prices shown in table 3-9. Thus, this frame does not represent non-urban consumers.

For the retail outlet sampling frame, BLS relies on the Point-of-Purchase Survey (CPOPS) conducted by the Census Bureau in 94 Primary



Sampling Units (PSUs) identified by BLS. PSUs are based on urban counties, groups of contiguous urban counties, or MSAs. For the household sample, a noncompact clustering procedure was employed which dispersed households evenly within a Census enumeration district (ED). More detailed sampling design information can be found in BLS's *Handbook of Methods* at <http://stats.bls.gov/opub/hom/homhome.htm>.

Prices for the goods and services used to calculate the CPI are collected in 91 PSUs located in 85 urban areas throughout the country. The sample size for the CPOPS totals about 21,000 retail and service establishments—supermarkets, department stores, gasoline stations, hospitals, etc. Food, fuels, and a few other items are priced monthly in all 85 locations. BLS field representatives collect all price information through visits or telephone calls in the household surveys. Price changes are computed based on a sample of outlets selected from locations identified by consumers. Specific sample items are then selected from each sample outlet to ensure that the market basket is representative of where households shop.

### Estimation

BLS routinely updates its price estimates for specific items among the collection of goods and services, for example, a new car model year. BLS employs three techniques to produce new price estimates. First, an item that is directly comparable to the previous discontinued good will be used to provide a price estimate. However, a substitute item may be inappropriate when goods change slightly in their characteristics. BLS relies on Hedonic regression modeling as a second "quality adjustment" for price estimates. This statistical technique can model the importance of various quality characteristics that add value to a particular good (the fiber content and construction of apparel products for instance). A researcher can estimate a Hedonic regression model that identifies the factors most important in determining the price of a good, and BLS field representatives will note these in their data collection. Imputation is a third quality adjustment used for "noncomparable" substitutions where BLS estimates the price change from previous averages. Detailed algorithms can be found in chapter 17 of the BLS

*Handbook of Methods* at <http://stats.bls.gov/opub/hom/homhome.htm>.

Effective January 1999, BLS began using a new formula for calculating the basic components of the Consumer Price Index for all Urban Consumers (CPI-U) and the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). The new formula, the geometric mean estimator, is used in index categories that comprise approximately 61 percent of total consumer spending represented by the CPI-U. Based on BLS research, it is expected that use of the new formula will reduce the annual rate of increase in the CPI by approximately 0.2 percentage point per year. Additional information on this change was published in the April 1998 CPI Detailed Report and is available on the Internet at <http://stats.bls.gov/cpihome.htm>.

### Accuracy

One of the CPI's limitations is that it represents price movements for urban residents and may not correctly represent nonurban consumption patterns. The CPI may also contain sampling error because it is estimated from a sample of consumer purchases. Nonsampling error may occur if respondents provide BLS field representatives with inaccurate or incomplete information. Another potential source of error identified by BLS may occur because of a time lag between the Point-of-Purchase Survey and the initiation of price collection for commodities and services at resampled outlets. Because of the time lag, the products offered by the outlet at the time pricing is initiated may not coincide with the set from which the CPOPS respondents were purchasing.

The CPI is also subject to response error when data are not collected because of non-response. BLS established a nonresponse auditing program in 1986. It reported that response rates in 1990 for transportation commodities and services were above 90 percent.

### Bias

Four categories of bias were identified in the BLS report, *Measurement Issues in the Consumer Price Index*, published in 1997. First, because of the fixed-weight nature of the index, the CPI creates substitution bias by placing too much weight

on items measured in previous surveys from which consumers may have shifted away. Second, the study found that the index did not account for consumers switching to discount stores. Third, a quality change bias was also identified when the differences between goods priced in two different periods cannot be accurately measured nor deduced from the accompanying price difference between the goods. Finally, the report noted that the CPI also had a new product bias because the index inadequately reflected consumer value of products introduced into the market. The commission concluded that the CPI overstated the true cost-of-living change by 1.1 percentage points per year.

**TABLE 3-10. Producer Price Indices for Transportation Services**

**TABLE 3-11. Producer Price Indices for Transportation Equipment**

Data shown in these tables are drawn from annual issues of *The Supplement to Producer Price Indexes* published by the Bureau of Labor Statistics (BLS) in the U.S. Department of Labor. These indexes represent a measure of outputs in all goods-producing American industries as well as partial coverage of service industries including transportation. BLS defines a price as the net revenue accrued to a specified production establishment from a specified kind of buyer for a specific product shipped under specific transaction terms on a specified day of the month. BLS collects this data series through surveys of a sample of establishments that report their prices from economic transactions.

### Data Collection

A BLS field economist visits an establishment or cluster of establishments selected for price sampling. The economist uses a disaggregation procedure to select a sample of transactions from all the establishment's revenue-producing activities. This disaggregation procedure assigns a probability of selection to each shipping or receipt category proportionate to its value within a reporting unit. In most cases, the final price index produced by the BLS requires that 1) there are at least three differ-

ent respondents to a survey, 2) at least two reporting units provide price information in a given month, and 3) no single respondent accounts for 50 percent or more of the weight for a given item.

BLS regional offices review field data for consistency and completeness. The national office then conducts a final review and a survey is then tailored specifically to establishments or clusters of establishments. BLS refers to these as repricing schedules and sends them to reporting establishments on a regular basis. Most prices refer to a reporting schedule on a particular day of the month, usually, the first Tuesday or the 13th of a month.

### Estimation

BLS collects prices for over 100,000 items. It utilizes several different weighting schemes for the numerous indexes produced because some products will have a greater effect on the movement of groupings of individual products. BLS utilizes the net output of shipment values as weights for the 4-digit SIC industries. Net output values include only shipments from establishments in one industry to other industry establishments and, thus, differ from gross shipment values. The latter would include shipments among establishments in the same industry, even if those establishments are separate firms. BLS also makes seasonal adjustments if statistical tests and economic rationale justify them, and imputes data when a participating company does not deliver a price report. BLS bases the missing price estimation on the average of price changes for similar products reported by other establishments.

### Accuracy

As in all surveys, the accuracy of producer price indexes depends on the quality of information voluntarily provided by participating establishments. One of the accuracy concerns of BLS revolves around the preferred use of realistic transaction prices (including discounts, premiums, rebates, allowances, etc.) rather than list or book prices. Before BLS fully changed its data collection method in 1986, a survey indicated that about 20 percent of traditional commodity indexes were based on list prices. The newer and more systematic methodology decreased the use of list prices.

BLS documentation (available at <http://stats.bls.gov/opub/hom>) provided no more details on sampling error, response rates, or the availability of generalized variance parameters or techniques for estimating them.

**TABLE 3-12: Personal Expenditures by Category**

**TABLE 3-13: Personal Consumption Expenditures on Transportation by Subcategory**

Data used in these tables are from the Bureau of Labor Statistics, *Annual Report of Consumer Expenditure Survey*. The Consumer Expenditure Survey (CEX) collects information from U.S. households and families on their buying habits (expenditures), income, and consumer characteristics. The strength of the survey is that it allows data users to relate the expenditures and income of consumers to the characteristics of those consumers. BLS uses 11 standard characteristics to classify consumers, including income, before-tax income class, age, size of the consumer unit, composition of the consumer unit, number of earners, housing tenure, race, type of area (urban or rural), region, and occupation.

The CEX is a national probability sample of households. The sampling frame (i.e., the list from which housing units are chosen) for this survey is generated from the 1990 census 100-percent detail file, which is augmented by a sample drawn from new construction permits. Coverage improvement techniques are also utilized to eliminate recognized deficiencies in the census.

**Data Collection**

The current survey consists of two separate surveys (Interview and Diary), each utilizing a different data collection technique and sample. Data is collected for each survey from approximately 5,000 households. In the Interview survey, each consumer unit (CU) in the sample is interviewed every three months over five calendar quarters. The interviewer uses a structured questionnaire to collect both the demographic and expenditure data in the Interview survey. The interviewer collects the demographic data in the Diary survey

whereas the respondent enters the expenditure data on the diary form. Both surveys accept proxy responses from any eligible household member who is at least 16 years old if an adult is not available after a few attempts to contact that person. The respondent family completes the Diary (or recordkeeping) survey at home for two consecutive one-week periods.

A reinterview program for the CEX provides quality control. The program provides a means of evaluating individual interviewer performance to determine how well the procedures are being carried out in the field. A member of the supervisory staff conducts the reinterview. Subsamples of approximately 6 percent of households in the Interview survey and 17 percent in the Diary survey are reinterviewed on an ongoing basis. A new diary form with more categories and expanded use of cues for respondents was introduced in 1991, based on results from earlier field and laboratory studies.

**Estimation**

Missing or invalid data on demographic or work experience are imputed. No imputation is done for missing data on expenditures or income. Selected portions of the Diary data are also adjusted by automated imputation and allocation routines when respondents report insufficient detail to meet publication requirements. These procedures are performed annually on the data. The imputation routines assign qualifying information to data items when there is clear evidence of invalid non-response.

The statistical estimation of the population quantities of interest, such as the average expenditure on a particular item by a CU or the total number of CUs in a particular demographic group, is conducted via a weighting scheme. Each CU included in the survey is assigned a weight that is interpreted as representing the number of similar families in the universe of interest, the U.S. civilian noninstitutional population. Readers should refer to [http://stats.bls.gov/opub/hom/homch16\\_c.htm](http://stats.bls.gov/opub/hom/homch16_c.htm) for the detailed weighting method.

Beginning with 1997 data, BLS introduced a new calibration method to compute weights in the Consumer Expenditure Survey. The weights are

calculated using a model-assisted, design-based regression estimator.

### Accuracy

The Consumer Expenditures Survey is a sample survey and hence is subject to two types of errors, nonsampling and sampling. Nonsampling errors can be attributed to many sources, such as differences in the interpretation of questions, inability or unwillingness of the respondent to provide correct information, mistakes in recording or coding the data obtained, and other errors of collection, response, processing, coverage, and estimation for missing data. The full extent of nonsampling error is unknown. Sampling errors occur because the survey data are collected from a sample and not from the entire population. Tables with coefficients of variation and other reliability statistics are available on request from the national office. However, because the statistics are shown at the detailed item level, the tables are extensive.

**TABLE 3-14. Cost of Owning and Operating an Automobile**

*Your Driving Costs* produced by the American Automobile Association (AAA) provided the data for this table. Prior to 1985, the cost figures are for a mid-sized, current model, American car equipped with a variety of standard and optional accessories. After 1985, the cost figures are for a composite of three current model American cars:

1. a 1999 Chevrolet Cavalier LS,
2. a 1999 Ford Taurus GL, and
3. a 1999 Mercury Grand Marquis GS.

Thus, the estimates are not reliable estimates for all cars.

Fuel costs were based on an average price of \$1.34 per gallon of regular unleaded gasoline, weighted 20 percent full-serve and 80 percent self-serve. Insurance figures were based on personal use of vehicles driven less than 10 miles to or from work, with no young drivers. Normal depreciation costs were based on the vehicle's trade-in value at the end of four years or at 60,000 miles.

American Automobile Association (AAA) analysis covers vehicles equipped with standard and optional accessories, including automatic transmission, air conditioning, power steering, power disc brakes, AM/FM stereo, driver-and passenger side air bag, anti-lock brakes, cruise control, tilt steering wheel, tinted glass, emission equipment and rear window defogger.

**TABLE 3-15a & 3-15b. Average Passenger Fare (Current and chained 1996 dollars)**

**TABLE 3-18. Total Operating Revenues**

### Air

The U.S. Department of Transportation, Bureau of Transportation Statistics (BTS), Office of Airline Information, reports passenger fares and operating revenues in its publication *Air Carrier Financial Statistics*. These numbers are based on 100 percent reporting by large certificated air carriers. Minor errors from nonreporting may occur but amount to less than one percent of all passenger or freight activity. The figures do not include data for all airlines; such as most scheduled commuter airlines and all nonscheduled commuter airlines.

### Class I Bus

Class I passenger motor carriers are required to report financial and operating information to BTS using form MP-1. (Prior to 1996, Class I carriers were required to report to the Interstate Commerce Commission.) Class I passenger motor carriers are defined as those having annual gross operating revenues, as adjusted for inflation, of \$5,000,000 or more. This table does not include Class I carriers whose data had not been received at the time of publication. Thus, these data do not represent total Class I passenger motor carrier activity.

### Transit

The American Public Transit Association (APTA) reports these figures, which are based on the annual National Transit Database report published by the USDOT, Federal Transit Administration (FTA). Section 15 of the Federal Transit Act requires federally funded transit agencies to provide detailed financial and operating data

including capital expenditures, revenues and expenses. These data are generally considered accurate because the FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or misinterpret certain data definitions. APTA conservatively adjusts FTA data to include transit operators that do not report to the database (private and very small operators and rural operators).

## Rail

Data are from *Railroad Facts* published annually by the Association of American Railroads (AAR). AAR figures are based on 100-percent reporting by all nine Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the R1 Annual Report. STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million in 1991 and adjusted annually in concert with changes in the "Railroad Freight Rate Index" published by the Bureau of Labor Statistics. In 1998, the threshold for Class I railroads was \$259.4 million. Declassification from Class I status occurs when a railroad falls below the applicable threshold for three consecutive years. Although Class I railroads represent only 2 percent of the number of railroads in this country, they account for over 90 percent of the industry's freight revenues.

## Intercity/Amtrak

Average passenger fare data are based on 100 percent of issued tickets, and thus should be accurate. Created as a publicly-owned for-profit corporation, Amtrak collects its own financial data and reports this information in its annual report. Auditing should ensure the accuracy of the operating revenue figures.

## Trucking and Courier Services (except air)

The Census Bureau's Transportation Annual Survey (formerly known as the Motor Freight Transportation and Warehousing Survey) is the source of this information. The sample survey represents all employer firms with one or more establishments engaged primarily in providing

commercial motor freight transportation or public warehousing services. It excludes motor carriers that operate as auxiliary establishments to non-transportation companies, as well as independent owner-operators with no paid employees. Thus, the data do not represent the total trucking industry.

As with all sample surveys, two types of errors are possible: sampling and nonsampling. Nonsampling errors may include response errors and mistakes in coding or keying data. For additional information about the survey and data reliability, the reader is referred to the Census Bureau website at [www.census.gov](http://www.census.gov).

## Water (Domestic)

Eno Transportation Foundation, Inc. is the source of these data. Eno estimates these figures by multiplying ton-mile figures by estimated revenue per ton-mile. The U.S. Army Corps of Engineers reports the ton-mile figures in its publication *Waterborne Commerce of the United States*, and the revenue per ton-miles figures are estimated by Eno..

## Oil Pipeline

Eno Transportation Foundation, Inc., publishes these data, which are based on Federal Energy Regulatory Commission (FERC) data and reported by the Oil Pipeline Research Institute for years 1977 to the present. FERC data originates from required quarterly reports filed by pipeline companies. Prior to 1977, the data are based on the former Interstate Commerce Commission data for regulated pipelines, and estimated to be 16 percent of the total of nonregulated pipelines.

## Gas Pipeline

These statistics originate from *Gas Facts*, published annually by the American Gas Association (AGA). AGA data are based on gas utilities participation and reporting to the Uniform Statistical Report and estimates for those companies not reporting based on recent historical experience. Varying percentages of nonreporters from year to year introduce minor reliability problems for time-series comparisons.

**TABLE 3-19. Employment in For-Hire Transportation and Selected Transportation-Related Industries**

Employment data by industry are from the National Employment, Hours, and Earnings estimates published by the Bureau of Labor Statistics (BLS), U.S. Department of Labor. These estimates originate from the Current Employment Statistics (CES) survey program. The CES is a monthly survey conducted by state employment security agencies in cooperation with the BLS. The survey provides employment, hours, and earnings estimates based on payroll records of nonfarm business establishments, including government.

BLS uses a stratified sample based on a sector's employment size, or the degree of variability among its establishments, or both. This ensures that BLS captures a more representative survey from employers with large payrolls. Thus, large establishments are certain of selection while smaller ones have less of chance.

### Data Collection

Data are collected electronically from about two-thirds of the respondents and by mail or fax from the remainder. The primary type of electronic reporting is touch-tone phone self-response; others are computer-assisted phone interviews and phone voice recognition technology. Increasingly, data are collected through electronic data interchange from a small but growing number of companies that have a large number of establishments across the country. Mail respondents submit Form 790 to the BLS each month. It is then edited and returned to the respondent for use again the following month. All firms with 250 employees or more are asked to participate in the survey, as well as a sample of smaller firms.

### Estimation

Employment estimates are made at what is termed the basic estimating cell level and aggregated upward to broader levels of industry detail by simple addition. Basic cells are defined by industry (usually at the 3- or 4-digit SIC level) and are stratified within industry by geographic region and/or size class in the majority of cases. Within

the wholesale trade, retail trade, and services divisions, most industries are stratified into three to five size classes (beginning in 1984).

Most national employment estimates are multiplied by bias adjustment factors to produce the monthly published estimates. Bias adjustment factors are used primarily to compensate for the inability to capture the entry of new firms on a timely basis. New firms contribute a substantial amount to employment growth each year, but there is a lag between the creation of a firm and its inclusion on the sample frame (i.e., the Unemployment Insurance universe file). It is, therefore, necessary to use modeling techniques to capture this segment of the population. BLS also performs seasonal adjustments for certain SIC industries.

### Accuracy

BLS does not publish data reliability information along with estimates. Instead, it provides estimation formula and the necessary parameters so that users can estimate standard errors. For additional information, see the "Explanatory Notes and Estimates of Error" in the BLS monthly publication *Employment and Earnings*.

The CES survey, which began over 50 years ago, predates the introduction of probability sampling as the internationally recognized standard for sample surveys. Instead, a quota sample has been used since its inception. Quota samples are at risk for potentially significant biases, and recently completed BLS research suggests that, despite the large CES sample size, employment estimates based on that sample at times diverge substantially from those that a more representative sample would have been expected to produce. This leads to an over-reliance on bias adjustment in the estimation procedure. Because bias adjustment is primarily based on past experience, it is limited in its ability to accurately reflect changing economic conditions on a timely basis.

### Government Employment

The Office of the Secretary provides employment figures for the U.S. Department of Transportation. State and local highway department employment figures are from the *State and Local Government Employment and Payroll*

*Estimates*, published by the U.S. Department of Commerce, Bureau of the Census. The data are for the 50 states and the District of Columbia. Employment and payroll data pertain to the month of October. At present, data are collected for one pay period that includes October 12 (regardless of the period's length) through the Public Employment Survey (PES).

Employment refers to all persons gainfully employed by and performing services for a government. Employees include all persons paid for personal services performed from all sources of funds, including persons paid from federally funded programs, paid elected officials, persons in a paid leave status, and persons paid on a per meeting, annual, semiannual, or quarterly basis. Excluded from employment statistics are unpaid officials, pensioners, persons whose work is performed on a fee basis, and contractors and their employees.

The Census Bureau derives full-time equivalent (FTE) employment by summing the number of full-time employees reported and converting the number of hours worked by part-time employees to a full-time equivalent amount. Up until 1985 data, the method used to calculate FTEs was based solely on payroll data. Effective with 1986 data, the annual employment survey started collecting data on the number of hours worked by part-time employees in order to provide a more accurate representation of full-time equivalent employment. No October 1985 FTE employment data are available.

Beginning in 1999, the Public Employment Survey (PES) was conducted using a separate sample of approximately 11,000 government units to improve data accuracy and survey efficiency. Government units meeting any of the following criteria are included in the survey: 1) counties with populations greater than 100,000; 2) cities with populations greater than 75,000; 3) townships in New England and Mid-Atlantic with populations greater than 50,000; 4) special districts with FTEs greater than 1000; 5) independent school districts with enrollment greater than 10,000; and 6) all dependent and independent schools providing college level education. In 1999, government units were sampled to obtain a relative standard error of 3 percent or less for FTE

and total payroll for each of the states by type of government groups.

Prior to 1993, the PES used a joint sample of approximately 24,000 units for both employment and finance. From 1993 to 1998, the sample size was reduced to around 14,000 units. The standard error for the PES prior to 1999 was designed to be around 3 percent for major state- or county-level estimates of finance variables (state-level for 1993-1998 and county-level prior to 1993). Employment estimates are made using regression, except when the number of noncertainty cases contributing to the estimate is less than 20, where a simple unbiased estimate is used.

#### **TABLE 3-20. Employment in Transportation Occupations**

#### **TABLE 3-22. Median Weekly Earnings of Full-Time Wage and Salary Workers in Transportation by Detailed Occupation**

Employment by detailed transportation occupation data are from the Occupational Employment Statistics (OES) survey, collected by the Bureau of Labor Statistics (BLS). The OES is a periodic mail survey of nonfarm establishments that collects occupational employment data on workers by industry. The OES program surveys approximately 725,000 establishments in 400 detailed industries. The average response rate for the last three years, according to a BLS official, averaged about 70 percent.

The sample is selected primarily from the list of business establishments reporting to the state unemployment insurance program. The OES sample initially stratifies the universe of establishments by three-digit industry code and size-class code. Establishments employing 250 employees or more are sampled with certainty. Establishments employing fewer than 250 employees but more than 4 employees are sampled with probability proportional to the size class employment within each three-digit industry. Establishments employing four or fewer employees (i.e., size class 1 establishments) are not sampled. Instead, the employment for these establishments are accounted for by assigning a larger sampling weight to

establishments employing five to nine employees (i.e., size-class 2 establishments). Within each three-digit industry/size-class cell, establishments are systematically selected into the sample through a single random start.

### Data Collection

Employers are the source of occupational data. Within establishments, the main source of occupational data reported by respondents is personnel records. Data are collected from respondents primarily by mail. Occasionally, visits are made to large employers and to other respondents who indicate particular difficulty in completing the questionnaires. Ordinarily, two mailings follow the initial mailing. After the third mailing, a subsample of the remaining nonrespondents is drawn and contacted by telephone. The OES survey follows a 3-year cycle. Three surveys are conducted alternately for manufacturing, nonmanufacturing, and the balance of nonmanufacturing industries.

### Estimation

During the sample selection process, each sampled establishment is assigned a sampling weight that is equal to the reciprocal of its probability of selection. For example, if an establishment on the sampling frame had a 1 in 10 chance of being selected into the sample, then its sampling weight is 10. For establishments that did not respond to the survey, a nonresponse adjustment factor is calculated and applied against the sampling weights of the responding establishments within each state/3-digit industry/size-class cell. Multiplying these adjustment factors by sampling weights increases the weight of the responding establishments so they can account for the missing employment data of the nonresponding establishments.

### Accuracy

The OES survey uses a subsample replication technique to estimate variances in occupational employment at the 3-digit industry/size-class level. For additional information on occupational employment estimates and measurements of sampling error associated with the estimates, the reader is referred to <http://stats.bls.gov/oeshome.htm>.

### TABLE 3-21. Average Wage and Salary Accruals per Full-Time Equivalent Employee by Transportation Industry

### TABLE 3-23. Total Wage and Salary Accruals by Transportation Industry

The *Survey of Current Business* (tables 6.3c and 6.6c) published by the U.S. Department of Commerce, Bureau of Economic Analysis, is the source of transportation wage and salary data. These estimates are based on BLS tabulations of employee wages that are covered by State unemployment insurance. As a component of the income side of National Income and Product Account, wages and salaries comprise part of the GDP calculation. These data reflect the monetary remuneration of employees in terms of wage accruals less disbursements. It is defined as the difference between wages and salaries on a "when-earned" basis, or accrued, and wages and salaries on a "when-paid," or disbursed basis. This computation was instituted in 1992 because a significant portion of bonus payments were missed in previous calculations. Readers should also refer to the earlier discussion of GDP methods and reliability for more detail.

### TABLE 3-24. Labor Productivity Indices for Selected Transportation Industries

The Bureau of Labor Statistic's (BLS) *Industry Productivity Measures* is the source of transportation labor productivity data. BLS develops industry productivity measures based on various data sources.

For rail, BLS uses freight ton-mile and passenger miles that are collected by the Surface Transportation Board (STB), the Association of American Railroads (AAR), and Amtrak. BLS also aggregates four different air transportation outputs to form a single productivity index: domestic passenger-miles, domestic freight ton-miles, international passenger-miles, and international freight ton-miles. Air transportation data come from *Air Carrier Traffic Statistics* and *Air Carrier Financial Statistics*, published by the U.S. Department of



Transportation, Bureau of Transportation Statistics. For petroleum pipeline, BLS relies on data from the Association of Oil Pipelines and derived an output index based on trunkline barrel-miles. A barrel-mile is one barrel of petroleum moved through one mile of pipeline.

### Estimation

BLS generally calculates labor productivity by dividing an index of output (in this case, ton-miles) by an index of hours. Output is derived with a weight adjusted Tornqvist formula that produces an output ratio for one year. BLS then combines these in a series that produces a chained output index. The hour indexes are developed from data in BLS's Current Employment Statistics (CES; see discussion above for table 3-12) and are the results of dividing the annual aggregate hours for each year by a base-period figure. Readers who need more detail, such as mathematical specifications or equations, should refer to Kunze and Jablonski (Kunze and Jablonski 1998) or call the Office of Productivity and Technology at BLS.

### Accuracy

BLS provides no measures of reliability. However, BLS makes an assumption that transportation outputs should be measured using the production of passenger-miles or freight-miles. Another school of thought might assume that many transportation firms or facilities are actually providing capacity rather than actual use. Thus, an argument can be made that productivity should be based on capacity rather than use. In fact, this is how BEA measures transportation output. To evaluate the BLS assumption, one study compared the two approaches by examining the different growth rates produced by BLS and BEA and found that in 25 of 35 service industries, the differences are within one percentage point. For transportation, differences in growth rates across BLS and BEA estimates were two percentage points or less (Kunze and Jablonski 1998).

Beginning with 1997 data, the indices for bus and petroleum pipelines did not meet BLS publication standards and are considered less reliable than those for other modes. These industries had between 14,000 and 15,000 employees, far below the 50,000-employee threshold established for

transportation industries by BLS. However, they both met a basic test of variability of the annual percent changes in the output per hour measure.

## GOVERNMENT REVENUES AND EXPENDITURES

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**TABLE 3-25a & 3-25b. Federal, State, and Local Government Transportation-Related Revenues and Expenditures, Fiscal Year (Current and constant 1996 dollars)**

**TABLE 3-26a & 3-26b. Federal Transportation-Related Revenues, Fiscal Years (Current dollars and constant 1996 dollars)**

**TABLE 3-27a & 3-27b. Federal Transportation-Related Expenditures by Mode, Fiscal Year (Current and constant 1996 dollars)**

**TABLE 3-28. Cash Balances of the Transportation-Related Federal Trust Funds, Fiscal Year**

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The main sources for federal-level data are the *Budget of the United States* and the *Appendix to the Budget*. These data are the "actual" figures as reported for the various transportation-related programs in the appendices of each year's budget document.<sup>1</sup> The figures are consistent from year to year and follow the definitional structure required by the Office of Management and Budget (OMB).

Primary sources for state and local transportation-related revenues and expenditures data are censuses and surveys collected by the U.S. Census Bureau. All units of government are included in

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<sup>1</sup> The federal budget is broken down into 20 functional categories, of which one is transportation (function 400). Function 400 is not tied to any one department or agency, but instead aggregates transportation functions wherever in the federal government they occur. Thus, the transportation function may include many activities, such as highway construction and safety, airways and airports, maritime subsidies, U.S. Coast Guard operations, railroads, and mass transit. It also covers grants-in-aid programs to support state and local activities. A good summary of the federal budget process can be found in Collender, Stanley E., *The Guide to the Federal Budget, Fiscal 1996* (Washington, DC: Urban Institute Press, 1995).

the Census of Governments, which is taken at five-year intervals for years ending in "2" or "7," and these data are "full counts," and not subject to sampling error.

State and local government data for noncensus years are obtained by annual surveys, which are subject to sampling error. For the U.S. totals of local government revenues and expenditures in this report, the sampling variability is in most cases small (less than 2 percent).

The federal figures in this report correspond to the federal fiscal year, which begins on October 1, while state and local data are for fiscal years that generally start in July. While this may create a small error in totals for any given year, the data are suitable for illustrating trends in public transportation finance. Programs that were terminated before 1985 are excluded from the tables. The totals for transportation revenues and expenditures in this report are the sum of the Census Bureau's state and local figures plus the total of the federal figures.

The source of the constant dollar deflators is *The Survey of Current Business*, August 1998, Bureau of Economic Analysis, table 3, "Chain Type Price Indexes." All inflation-adjusted data are for the base year 1992, instead of 1987 as in the previous editions of the NTS. Note that different deflators are used for the federal data and the state and local data. Thus, if expenditures are totaled across different levels of government in constant dollars before and after Federal grant transfers, the totals do not match.

### Limitations of the Source Data Sets

Some federal agencies, such as the U.S. Department of Health and Human Services, have substantial transportation activities, but do not distinguish these activities as individual programs and do not report transportation revenues, obligations, and expenditures as separate items. There is reason to believe that the effect of omitting the transportation activities in those agencies and programs with missing data is relatively small (less than 10 percent).

The same is true in the case of Census Bureau data at the state and local levels. It is known, for example, that the states expend funds for intercity

rail and bus services and pipeline safety programs, but the Census Bureau does not report these outlays at the state and local government levels separately. BTS has collected data from other sources or estimated data using assumptions about ratios between federal, state, and local funds. Data from other sources include the Federal Highway Administration's (FHWA's) *Highway Statistics* report for federal-level highway data, the National Aeronautics and Space Administration (NASA) aeronautics expenditures data from the *Aeronautics and Space Report of the President*, and pipeline expenditures data from direct agency contacts.

The Census Bureau's database also does not include detailed modal information on interest earnings and bond issue proceeds on the revenue side nor bond retirement and interest payments on the expenditure side. In addition, the Census Bureau's highway expenditures data, in particular, do not include highway law enforcement expenditures, which form a part of the state and local highway expenditures published in *Highway Statistics*. However, to maintain consistency between the different modes regarding the types of revenues and expenditures included, these additional data from the *Highway Statistics* report have *not* been used.

### Transportation Revenues

Transportation revenue estimates include transportation-related user charges, taxes, or fees earmarked for transportation-related expenditures, and funds that support federal transportation programs through the U.S. government's General Fund. Estimates include transit fares from systems owned and operated by state and local governments, including those systems operated under contract by a private firm while the government maintains day-to-day financial oversight.

Not all transportation-related revenues are included, however. Other funds exist that could be categorized as transportation-related revenues, such as local government property taxes on vehicles, equipment, and streets, and state income taxes to support rail and intercity bus services. However, it is impossible to identify these revenues because they are not shown as such in the source materials used to compile the database in this report.

In addition, taxes collected from users of the transportation system that go into the General Fund are not included as transportation revenues. This occurred in 1981 and 1982 when the Airport and Airway Trust Fund (AATF) revenues were assigned to the General Fund of the Treasury rather than the AATF.

The reader should note that in the case of rail transportation, revenue estimates do not exist since both freight and passenger rail yield no revenues to federal, state, or local governments.

Federal transportation revenues generally consist of trust-fund collections from user charges, such as fuel taxes, vehicle taxes, registration and licensing fees, and air passenger ticket taxes. Interest earned on fund balances are added to these funds, along with any damage payments made by private parties and deposited in the funds to reimburse the government for related fund expenditures.

The five transportation-related Federal trust funds are established by law:

1. Highway Trust Fund (HTF) (which includes both highway and transit accounts),
2. Airport and Airway Trust Fund (AATF),
3. Harbor Maintenance Trust Fund (HMTF),
4. Inland Waterways Trust Fund (IWATF), and
5. Oil Spill Liability Trust Fund (OSLTF).

These tables also contain data relating to the Pipeline Safety Fund, which has not been designated by law as a trust fund, but has been set up to record revenues and disbursements of fees earmarked to support the pipeline safety program. A status report of each of these funds made annually in the *Appendix to the Budget* shows their revenues, expenditures, and interest earnings.

## Air Revenues

Federal air revenues are derived from the AATF, which includes a passenger ticket tax and other taxes paid by airport and airway users on air cargo and general aviation fuel. Most of this trust fund is devoted to airport grants and capital improvements, such as new radar and traffic con-

trol towers. Within certain limits set by Congress, some of the remaining money can be used to cover the Federal Aviation Administration's (FAA) operation and maintenance expenses. The portion of the FAA's operation and maintenance expenses not paid from the trust fund revenues are financed by general funds of the Treasury.

State and local revenues from the air mode are derived from airport charges. Beginning in 1992, local governments began collecting passenger facility charges and spending these revenues (both subject to FAA approval) to finance capital programs. The collection of passenger facility charges was authorized by the Aviation Safety and Capacity Expansion Act of 1990.<sup>2</sup>

## Highway Revenues

The major source of Federal highway revenues is the Highway Trust Fund (HTF). HTF revenues are derived from various excise taxes on highway users (e.g., motor fuel, motor vehicles, tires, and parts and accessories for trucks and buses). The money paid into the fund is earmarked primarily for the Federal-aid highway program. The excise tax on gasoline is the greatest individual source of HTF revenues. Although the excise tax per gallon changed several times during the 1985 through 1995 period, the amount dedicated to the HTF only increased once during that time. Portions of the gasoline excise tax per gallon were dedicated to budget deficit reduction and to the Leaking Underground Storage Tank Trust Fund.

State and local highway revenues include state and local taxes on motor fuels, motor vehicle licenses, and motor vehicle operator licenses, along with state and local charges for regular toll highways and local parking charges. Regular highway charges (revenues) include reimbursements for street construction and repairs; fees for curb cuts and special traffic signs; and maintenance assessments for street lighting, snow removal, and other highway or street services unrelated to toll facilities. Local governments finance local road and street programs with special assessments and property taxes that may be commingled with other local revenue in a general fund. Consistent with federal revenues, state and

<sup>2</sup> Public Law 101-508, 104 Stat. 1388 (November 5, 1990).

local transportation revenues in this report do not include general funds that may be allocated to transportation.

### Transit Revenue

Effective April 1983, one cent per gallon of the federal excise tax on gasoline sales was set aside for the Mass Transit Account of the Highway Trust Fund; on December 1, 1990, this was increased to 1.5 cents per gallon. Although highway users pay the taxes, these funds are treated as federal transit budget revenues in calculating user coverage.

State and local transit revenues include revenues from operations of public mass transportation systems (rapid transit, subway, bus, street, railway, and commuter rail services), such as fares, charter fees, advertising income, and other operations revenues. They exclude subsidies from other governments to support either operations or capital projects.

### Waterway and Marine Revenues

Federal water revenues come from four primary sources: the Inland Waterways Trust Fund, the Harbor Maintenance Trust Fund, the Oil Spill Liability Trust Fund, and tolls and other charges collected by the Panama Canal Commission.

Established by the Inland Waterways Revenue Act of 1978, the Inland Waterways Trust Fund has been in effect since fiscal year 1981. The source for the fund is a fuel tax paid by freight carriers on inland waterways. From this tax of 24.2 cents per gallon, 4.3 cents goes for deficit reduction, and a statutory maximum of 20 cents (raised to that level from the previous maximum of 19 cents at the beginning of 1995) flows to the Trust Fund. Funds are earmarked for 50 percent of the construction and rehabilitation costs of specified inland waterway projects.

### Rail Revenues

There are no governmental transportation revenues for rail. (Rail generates fuel taxes that are designated for deficit reduction and, thus, are not considered transportation revenues in these tables. Rail also pays substantial taxes because it does not have a publicly maintained infrastructure.)

### Pipeline Revenues

The Pipeline Safety Program is funded by user fees assessed on a per-mile basis. The assessments are made on each pipeline operator regulated by the Office of Pipeline Safety (OPS) of the Research and Special Programs Administration in the U.S. Department of Transportation. There are no state and local revenues for pipeline.

### General Support Revenues

General Support revenues come from the Emergency Preparedness Fund, which is generated from fees paid by registered shippers of hazardous materials. RSPA administers and distributes the revenues to states, territories, and tribes through the Hazardous Materials Emergency Preparedness (HMEP) grant program, which is authorized by the Federal Hazardous Materials Transportation Law.

### Transportation Expenditures

Expenditures, rather than obligations, are used in these tables because they represent the final, actual costs to the government, by year, for capital goods and operating services required by the transportation programs. Obligations suggest government commitment to future transportation expenditures, but do not indicate when the funds will actually be disbursed or even if the amounts obligated will be spent.

It is important to recognize that in some accounts in the *Budget of the United States Government*, expenditures for a particular year understate total government disbursements. This is because certain offsetting collections of fees and assessments from the public are not treated as government revenues, but deducted from disbursements to determine expenditures. These collections are those mandated, by statute, to be applied directly to fund agency expenditures rather than being transferred to the Treasury. For this reason, expenditures do not necessarily indicate how much the Federal government actually spends on transportation each year.

### Air Expenditures

Federal expenditures reported here consist of all FAA expenditures, such as those associated

with constructing, operating, and maintaining the national air traffic system; administration of the airport grant program; safety regulation; and research and development. NASA expenses related to air transportation are also included.

State and local expenditures for air include the operation and maintenance of airport facilities, as administered by local airport and port authorities—quasi-government agencies with responsibilities for promoting safe navigation and operations for air modes.

### Highway Expenditures

FHWA expenditures include funds for Federal Aid Highways (financed from the HTF) and the Interstate Substitution and Railroad Crossing Demonstration (financed from the general fund). The National Highway Traffic Safety Administration (NHTSA) expenditures include: operations, research, and highway traffic safety grants. Federal highway expenditures also include road construction activities managed by the Department of the Interior's National Park Service, Bureau of Indian Affairs, Bureau of Reclamation, and Bureau of Land Management; the Department of Agriculture's Forest Service; the Department of Housing and Urban Development; and other federal agencies.

State and local governments' highway expenditures reported by the Census Bureau are generally slightly lower than those reported in FHWA's *Highway Statistics* because the FHWA includes some highway expenditure data, such as law enforcement activities and patrols, and policing of streets and highways not included in the Census data. Box 3-1 outlines the major differences in Census Bureau and FHWA calculation of state and local highway transportation financial statistics.

### Transit Expenditures

Federal expenditures include grants to states and local agencies for the construction, acquisition, and improvement of mass transportation facilities and equipment and for the payment of operating expenses. Several other items are also included: Federal Railroad Administration (FRA) commuter rail subsidies related to the transition of Conrail to the private sector; research and admin-

istrative expenses of the Federal Transit Administration (FTA); and Federal interest payment contribution to the Washington Metropolitan Area Transportation Authority (WMATA).

### Waterway and Marine Expenditures

Federal expenditures comprise those parts of U.S. Coast Guard's expenses that are transportation-related, such as aids to navigation, marine safety, and marine environmental protection. All expenses of the U.S. Maritime Administration are included, such as subsidies for construction and operation of vessels by U.S.-flag operators, research and development, and training of ship officers. Also included are those expenses of the U.S. Army Corps of Engineers for construction and operations and maintenance of channels, harbors, locks and dams; protection of navigation; the salaries and expenses of the Federal Maritime Commission; and the expenses of the Panama Canal Commission.

State and local governments incur water transportation expenditures by operating and maintaining water terminal facilities within ports and harbors.

### Rail Expenditures

Federal rail transportation expenditures include:

1. expenses for rail safety enforcement;
2. inspection and program administration;
3. railroad research and development;
4. financial assistance to states for planning, acquisition, rail facility construction, and track rehabilitation with respect to low volume freight lines;
5. grants to Amtrak, including funds to upgrade the high-speed line between Boston, MA, and Washington, DC, owned by Amtrak (the Northeast Corridor Improvement Program); annual appropriations to cover operating losses; and funds to invest in new equipment and facilities;
6. the purchase of redeemable preference shares for track rehabilitation and line acquisition; and

Box 3-1.

**U.S. Census Bureau and Federal Highway Administration calculations of state and local transportation financial statistics differ in the following ways:**

ITEM	CENSUS	FHWA
Motor Fuel Tax Revenues	Includes state and local tax revenues on any fuel used in motor vehicles, and on gasoline used by aircraft.	Includes state and local fuel tax revenues attributed to highway use of fuels, including diesel fuel, gasohol and liquefied petroleum gas used by private and commercial highway use motor vehicles and transit. Does not include revenues on gasoline used by aircraft.
Motor Vehicle License Tax Revenues	Includes vehicle mileage and weight taxes on motor carriers; highway use taxes; or off-highway fees.	Does not include vehicle mileage and weight taxes on motor carriers; highway use taxes or off-highway fees.
Local Parking Charges Revenues	Includes local parking revenues.	Not explicitly collected.
Highway Expenditures	Excludes patrols or policing of streets and highways; traffic control activities of police or public safety agencies; law enforcement and safety activities of vehicle inspection enforcement, and vehicle size and weight enforcement; street cleaning activities; and roads within parks maintained by a park agency.	Includes patrols or policing of streets and highways; traffic control activities of police or public safety agencies; law enforcement and safety activities of vehicle inspection enforcement, and vehicle size and weight enforcement; street cleaning activities; and roads within parks maintained by a park agency.

7. loan guarantee defaults for railroad rehabilitation and improvement and Conrail labor protection.<sup>3</sup>

The local rail freight assistance program, a program of FRA grants to state governments, has had a 70:30 percent federal-state funding share since 1982.

**Pipeline Expenditures**

The OPS reimburses state agencies up to 50 percent of their costs to carry out the state's pipeline safety program. Federal expenditures are for the enforcement programs, research and devel-

opment, and grants for state pipeline safety programs.

**General Support Expenditures**

General Fund expenditures include all of the expenses of the following agencies: Office of Inspector General, National Transportation Safety Board, all expenses of RSPA (except pipeline expenditures) and the Office of the Secretary of Transportation (except for payments to Air Carriers and the Commission on Aircraft Safety).

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<sup>3</sup> Funds in the Conrail Labor Protection Program were provided for benefits to Conrail employees deprived of employment because of work force reductions and other actions. This program no longer exists since Conrail has been returned to the private sector. In 1988, the unobligated balances available from this program were transferred to the USCG and in 1990 they were returned to the U.S. Treasury.

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## Chapter 4 Energy and the Environment

### PETROLEUM SUPPLY

**TABLE 4-1. Overview of U.S. Petroleum Production, Imports, Exports, and Consumption**

The petroleum supply system is extremely complicated, with many different processes, products, and entities involved. Briefly, crude oil is produced or imported, transported to refineries where it is refined into various products, and then transported to markets. Imports and exports of crude oil and products must be accounted for, as must be nonpetroleum components of final products, such as natural gas plant liquids and ethanol for gasoline blending.

The U.S. Department of Energy, Energy Information Administration (EIA) collects extensive data at select points in the petroleum supply system. Sixteen surveys are conducted by EIA's Petroleum Supply Reporting System to track the supply and disposition of crude oil, petroleum products, and natural gas plant liquids:

- five weekly surveys cover refineries (form EIA-800), bulk terminal stocks (form EIA-801), product pipelines (form EIA-802), crude stocks (form EIA-803), and imports (form EIA-804).
- eight monthly surveys cover the same five points plus tanker and barge movement (form EIA-817), gas processing facilities (form EIA-816), and oxygenates (form EIA-819M).
- one survey (form EIA-807) collects propane data on a monthly basis in the warmer months (April-September) and on a weekly basis in the colder months.
- one annual survey determines production capacity of oxygenates and fuel ethanol (form EIA-819A), and
- one annual survey determines refinery fuel use, capacity, and crude oil receipts by transportation mode (form EIA-820).

The five weekly surveys target key points in the petroleum supply system. They do not include all companies, but sample 90 percent of volume at each selected point in the supply system. EIA ranks the companies involved in the survey and sends surveys as it scrolls down the list, stopping when it reaches the 90 percent level. Although 100 percent coverage is sacrificed, this method keeps the level of incoming data manageable and avoids burdening the smallest companies. All data are reviewed and anomalies checked.

Monthly surveys provide data that are used in the monthly and annual reports. They are similar to the weekly surveys, but are more exhaustive in both the range of data collected and the depth of the collection. Sample sizes and response rates for several of the key points in the supply system are shown in table 4-1. The eight monthly surveys cover the industry more accurately than the weekly surveys and provide some double-check points that the other surveys do not. EIA expends considerable effort to ensure that its data are as accurate as possible. Revisions are made throughout the year. For example, EIA's *Annual Energy Review 1996*, released in July 1997, provided a

Table 4-1.  
**Average Response Rates for Monthly Surveys, 1998**

Survey site	Average universe site	Average number of respondents	Percent
Refinery	252	243	96.3
Bulk terminal	300	287	95.6
Pipeline	81	80	99.3
Crude oil stocks	174	169	99.1

NOTE: The average response rate is calculated by summing individual monthly response rates and dividing by 12.

SOURCE: Tammy G. Heppner and Carol L. French, Energy Information Administration, U.S. Department of Energy, Accuracy of Petroleum Supply Data (Washington, DC: 1998).



preliminary 1996 number for total petroleum production of 8.30 million barrels per day (mmbd). The *Annual Energy Review 1997*, released a year later, revised that to 8.25 mmbd, and the 1999 *Review* reported 8.29 mmbd.

No complicated survey is likely to be 100 percent accurate. EIA lists four sources of potential systematic errors:

1. Some members of the target population are missed. EIA reports that it continually reviews the lists and searches industry periodicals and newspapers to identify new actors. Considering the nature of the petroleum industry, it is very unlikely that companies with significant production are not surveyed.

2. Some members of the target population do not respond. EIA reports a 97 percent response rate for monthly surveys. For some points in the supply system, the average response is over 99 percent. Survey respondents are required by law to respond, but some nonresponse is inevitable, especially among small companies. EIA assumes that the nonrespondent's value for that month is the same as for the previous month except for imports. Since imports vary widely, with respondents frequently having no imports, EIA assumes a nonresponse means zero imports. It can be assumed that EIA is good at "filling in the blanks." Assuming for illustration purposes that 0.5 percent of production does not respond, and that EIA is 90 percent accurate in covering the gap, then there is a possibility of a 0.05 percent error. Applying that to total production of 8.29 mmbd in 1999 suggests that there could be an error of 0.0041 mmbd (4,100 barrels per day), which would not affect the published number.

3. The most serious problem may be response error. A company may have poor data, perhaps as a result of imperfect measurements, or it may transmit the wrong number. EIA has no control over a company's data quality. Companies have incentive to measure their inputs and products accurately. Otherwise, they may be cheating themselves or risking ill will with their customers or suppliers. However, no instrumentation is perfectly accu-

rate. The high throughput of, say, a refinery with capacity of several hundred thousand barrels per day, with a variety of products changing density and some lost or used on site, is very complicated to measure. Instrumentation errors are likely to be systematic at any one site, although they will be more nearly random in the aggregate for all facilities. There is potential for small but significant overall errors.

Mistakes may be made in recording and transferring the data. EIA reviews the data and flags gross errors or missing data for review by the respondent. However, not all errors will be picked up by EIA and/or the respondent. Overall, response errors probably are several times as large as nonresponse errors, but it is beyond the scope of this profile to estimate them.

4. The final potential source of systematic error is in the clarity of the survey form, i.e., whether all respondents interpret it correctly. No doubt errors and ambiguities can creep into a form, but at least for petroleum supply, that does not appear to be a major risk. The supply system is not changing rapidly, and EIA should be able to keep with it and the terminology. However the final digit of EIA's published supply data is questionable.

For additional information on survey methodology and statistical reliability, the reader is referred to the EIA reference cited in the tables or the EIA Internet site at [www.eia.doe.gov](http://www.eia.doe.gov).

## FUEL AND ENERGY CONSUMPTION

**TABLE 4-1. Overview of U.S. Petroleum Production, Imports, Exports, and Consumption**

**TABLE 4-2. U.S. Consumption of Energy from Primary Sources by Sector**

**TABLE 4-3. Domestic Demand for Refined Petroleum Products by Sector**

**TABLE 4-4. U.S. Energy Consumption by the Transportation Sector**

**TABLE 4-7. Domestic Demand for Gasoline**

Petroleum consumption is far more complex to measure than supply. Instead of a few hundred companies at most measuring points in the supply system, there are tens of millions of consumers. It would be impossible for any survey of individual consumers to produce the high rate of return of U.S. Department of Energy (DOE), Energy Information Administration's (EIA's) supply surveys. EIA's transportation data collection is further limited by the termination of the Residential Transportation Energy Consumption Survey (RTECS). Therefore, EIA uses surveys of sales of products (e.g., Form EIA-821: Annual Fuel Oil and Kerosene Sales Report) or tax collection data from the U.S. Department of Transportation, Federal Highway Administration (FHWA).

EIA reviewed the accuracy of its energy consumption data in a 1990 monograph *Energy Consumption by End-Use Sector, a Comparison of Measures by Consumption and Supply Surveys*. Unfortunately, this monograph does not discuss the transportation sector because the consumption and supply surveys were not comparable. However, some of the results from other sectors indicate the discrepancies between supply and consumption surveys. Table 4-2 shows the ratio of fuel supplied to the sector to consumption reported by the sector in consumption surveys.

In most cases, supply is reported as substantially larger than consumption. Supplies of fuel oil to the commercial sector are reported at almost

twice the level of consumption reported by that sector. Some of the discrepancies may be due to definition differences (e.g., fuel oil for apartment buildings is included in commercial supply surveys but not in consumption surveys.) Overall, however, the differences are too large for great confidence in the accuracy of the data.

If transportation had been reviewed in the same format, it is likely that the discrepancies would have been larger. Most transportation fuel (gasoline for automobiles) is purchased in small quantities at irregular intervals and cannot be checked simply by looking at a utility bill. Hence, highway transportation energy consumption surveys must be extensive to avoid the risk of large uncertainties in the data. But, with the termination of the RTECS, EIA ceased conducting such surveys. Consumption data must be derived indirectly from sales of petroleum products and tax collection data. While petroleum supply may be accurate to one decimal place, it is likely that disaggregating by sector use may be within plus or minus several percentage points, or perhaps about half a quadrillion British thermal unit (Btu) in table 4-1.

### Motor Gasoline

Almost all gasoline is consumed in the transportation sector. Small amounts are used in the commercial sector for nonhighway use and the industrial sector, which includes agriculture, construction, and other uses. Subtracting estimates of those uses from the known total sales yields the transportation sector's total, which is further subdivided into highway and marine use. Aviation gasoline is, of course, used entirely in the transportation sector (for a very few high-performance automobiles as well as small aircraft).

Data on actual sales is collected by the states for revenue purposes. These data are forwarded to FHWA. EIA uses the data from FHWA to allocate highway consumption of motor gasoline among the states. For 1998, FHWA reported 124.7 billion gallons of gasoline sold nationally for highway use. EIA's table 5.12b of the *Annual Energy Review 1999* lists 8.13 mmbd of gasoline supplied for the transportation sector, the same as 124.7 billion gallons.

Table 4-2.  
**Reported Ratio of Fuel Supply to Reported Consumption**

Sector	Electricity	Gas	Oil
Residential	1.05	.92	.92
Commercial	0.91	1.38	1.96
Industrial	1.18	1.28	1.34

SOURCE: U.S. Department of Energy, Energy Information Administration, *Energy Consumption by End-Use Sector, A Comparison of Measures by Consumption and Supply Surveys*, DOE/EIA-0533 (Washington, DC: 1990).

Such close agreement between supply and demand is not totally convincing. Definitions are unique to each state (e.g., whether gasohol is counted as pure gasoline or part gasoline and part renewables), measurement points vary from state to state, and each state handles losses differently. Hence, the total of all states' sales of gasoline is not entirely consistent.

Separation of highway from nonhighway uses of gasoline is, by necessity, based in part on careful estimates. Nevertheless, overall gasoline sales are well documented, and the separation is probably fairly accurate. Refinery output of motor gasoline was 7.94 mmbd in 1999, which is probably accurate to the first decimal place and maybe a little better. The transportation sector's 8.13 mmbd would have about the same accuracy.

### Diesel Fuel

Diesel fuel is used in highway vehicles, railroads, boats, and military vehicles. Sales are only about 30 percent of gasoline in the transportation sector, but uncertainties are greater. More diesel than gasoline is used for nonhighway purposes, especially agriculture and construction. In addition, there has been more potential for cheating to avoid the tax; heating oil is virtually the same as diesel fuel and can easily be transferred to a vehicle. However, this is less significant now that tracers have been added to fuel oil. After the addition of tracers, the amount of transportation diesel fuel use jumped.

To estimate diesel fuel sales by mode, EIA starts with the total supply of distillate fuel and subtracts the small amount sold to electric utilities (the most accurately known sector, as measured by EIA Form EIA-759). The remainder is divided among the other end-use sectors according to EIA's sales surveys (Form EIA-821: Annual Fuel Oil and Kerosene Sales Report, and Form EIA-863: Petroleum Product Sales Identification Survey).

This method introduces several potential elements of inaccuracy. First, the surveys of each sector are probably less accurate than the supply surveys noted earlier. Companies and individuals may inadvertently send incorrect data, or not

respond at all. Then EIA has to determine what adjustment factor to use for each end-use sector. Since each sector will have a different response rate to the surveys, the adjustments will be different. Large adjustments can introduce large errors. EIA has not published its adjustments for the transportation sector. As shown in table 2, the adjustments in other sectors range from 5 to 96 percent of reported consumption. Even a 20 percent adjustment could introduce an error of one or two percentage points (plus or minus) for any one sector.

Overall, the accuracy of diesel fuel use in the transportation sector should be viewed with some skepticism.

### Jet Fuel

Jet fuel is the only other petroleum-based fuel that is used in large quantities (over 1 million barrels/day) in the transportation sector. Virtually all of it is used by airlines. These data are accurate because airlines are required to report usage, and because there are relatively few certificated air carriers, data collection should be manageable.

## NONPETROLEUM FUELS CONSUMPTION

**TABLE 4-10. Estimated Consumption of Alternative and Replacement Fuels for Highway Vehicles**

Collectively, oxygenates, natural gas, electricity, and various alternative fuels amount to only about 3 percent of all energy used in the transportation sector. While this may not be much greater than the error bars associated with petroleum use, it is important to track changes in these fuels accurately.

### Oxygenates

Oxygenates, mostly methyl tributyl ether (MTBE), which is derived from natural gas and ethanol, are part of mainstream gasoline supply. They are measured routinely with petroleum supply (forms EIA-819A and 819M). Consumption

is estimated from production, net imports, and stock changes. Refineries and other entities are required to report data on oxygenates, and EIA also monitors production capability to provide a crosscheck. Thus, oxygenates data are likely to be reasonably accurate.

## Natural Gas

Natural gas is used in the transportation sector mainly as the fuel for compressor stations on natural gas transmission lines. A small but growing amount is used in compressed or liquefied form in vehicles. EIA collects data on natural gas much as it does for petroleum, but the system is much simpler. Natural gas transmission companies may not know exactly how much gas is used in compressor stations, but they have a good idea based on the size of the equipment and the load on the line. The reported numbers probably are reasonably accurate. Data on natural gas-fueled vehicles are collected by DOE via Form-886, which is sent to fuel suppliers, vehicle manufacturers, and consumers. In addition, private associations and newsletters are important sources of information on alternative vehicles and alternative fuels use. Since most groups work cooperatively with DOE, it is likely that the data reported are accurate. EIA tracks the number of natural gas vehicles and the number of refueling stations to provide a cross check on estimates of natural gas consumption.

## Electricity

Electricity powers intercity trains (Amtrak) and intracity rail systems. In addition, the number of electric vehicles is growing. There is considerable uncertainty over the energy consumed by these modes. Amtrak no longer provides national totals of its electricity consumption. Data on intracity transit is based on U.S. Department of Transportation, Federal Transit Administration's (FTA's) National Transit Database that contains information for directly operated services by federally funded transit agencies. Section 15 of the Federal Transit Act requires that these agencies provide detailed financial and operating information, including energy use. Although the data is generally considered accurate because FTA reviews and validates information submitted, reliability

may vary because some transit agencies cannot obtain accurate information or may misinterpret certain data.

If electric vehicles become important over the next decade or two, dedicated charging stations may become commonplace, which could provide accurate data. Fleet owners (e.g., electric utilities) can keep accurate records, but individuals who plug their vehicles in at home may not. Electricity use must be estimated from the number of such vehicles and the expected driving cycles. Hence, data on electric power for transportation must be viewed as an estimate.

It should also be noted that electricity is a form of work that usually is generated from heat with the loss of about two-thirds of the energy. Automobile engines are equivalent to electric generators in that they convert chemical energy to heat and then to work, losing most of the energy as waste heat. When electrical energy is compared to petroleum in transportation, the waste heat must be included for consistency. A kilowatt-hour of electricity is equivalent to 3,413 British thermal units (Btu), but about 10,000 Btu of heat are required to produce it. This factor is dropping as generators become more efficient. High efficiency gas turbines may require 8,000 Btu or less, but the average is much higher. It is usually impossible to tell where the power for a specific use is generated, so average figures for a region are used to estimate the waste energy, a factor that further reduces the accuracy of the data.

## Alternative Fuels

In addition to oxygenates, natural gas, and electricity, alternative fuels include ethanol and methanol. EIA tracks the numbers of such vehicles through Form-886, state energy offices, federal demonstration programs, manufacturers, and private associations. These numbers probably are fairly accurate although it is difficult to monitor retirements. Fuel consumption is estimated from the types of vehicles in operation, vehicle miles traveled, and expected fuel efficiency. Adjustments are necessary for the relatively few flexible-fuel vehicles. Obviously, the reported data are estimates only.

## FUEL AND ENERGY CONSUMPTION BY MODE

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**TABLE 4-5. Fuel Consumption by Mode of Transportation**

**TABLE 4-6. Energy Consumption by Mode of Transportation**

**TABLE 4-8. Certificated Air Carrier Fuel Consumption and Travel**

**TABLE 4-9. Motor Vehicle Fuel Consumption and Travel**

**TABLE 4-11. Passenger Car and Motorcycle Fuel Consumption and Travel**

**TABLE 4-12. Other 2-Axle 4-Tire Vehicle Fuel Consumption and Travel**

**TABLE 4-13. Single-Unit 2-Axle 6-Tire or More Truck Fuel Consumption and Travel**

**TABLE 4-14. Combination Truck Fuel Consumption and Travel**

**TABLE 4-15. Bus Fuel Consumption and Travel**

**TABLE 4-16. Transit Industry Electric Power and Primary Energy Consumption and Travel**

**TABLE 4-17. Class I Rail Freight Service Fuel Consumption and Travel**

**TABLE 4-18. Amtrak Fuel Consumption and Travel**

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Fuel consumption data are collected quite differently than supply data collected by the U.S. Department of Energy, Energy Information Administration (EIA). Highway fuel consumption, for example, is based on U.S. Department of Transportation, Federal Highway Administration (FHWA) data collected from states in the course of revenue collection. EIA starts from the fuel delivered to transportation entities.

### Highway

Highway fuel data (tables 4-5, 4-9, and 4-11 through 4-15) are collected mainly by FHWA. All states plus the District of Columbia report total fuel sold along with travel by highway category

and vehicle registration. Data typically flows from state revenue offices to the state departments of transportation to FHWA. Even if reporting is reasonably accurate, some data are always anomalous or missing and must be modified to fit expected patterns. In addition, as discussed earlier, there are some significant differences in methodology and definitions among the states. In particular, states differ in where the tax is applied in the fuel supply system, how gasohol is counted, how nonhighway use is treated, and how losses are handled.

Nonhighway use of gasoline and diesel fuel is a particularly large source of potential error. Some states designate nonhighway users as tax-exempt, others make the tax refundable. In either case, many people won't bother to apply if the amount of money is small. Nonhighway use of diesel fuel is especially large because many construction and agricultural vehicles are diesel powered. Thus, the fraction of petroleum attributed to transportation could be overestimated. On the other hand, some nonhighway fuel finds its way into the transportation system because heating oil can be used as diesel fuel, evading the tax. Tracers are now added to heating oil, which appears to have reduced the level of such tax evasion—if found in a truck's fuel tank, the tracer indicates diversion from a nontaxed source.

Breaking fuel use down by class of motor vehicle introduces the potential for error. FHWA must estimate the miles each class is driven and the fuel economy. Estimation of miles is based on the 1995 Nationwide Personal Transportation Survey (NPTS), administered by FHWA, and the Vehicle Inventory and Use Survey (formerly known as the Truck Inventory and Use Survey) conducted by the U.S. Census Bureau. For information about these two surveys, the reader is referred to the technical appendix of *Our Nation's Travel*, available from the FHWA, Office of Highway Information Management; and the 1997 Census of Transportation, available from the Economics and Statistics Administration within the Census Bureau. Fuel economy is based on state-supplied data, TIUS, and the National Highway Traffic Safety Administration data on new car fuel economy, which must be reduced by about 15 percent to reflect actual experience on the road. Overall,

both vehicle-miles of travel and fuel economy are estimates.

Fuel consumption by buses is particularly uncertain. FHWA collects data on intercity buses, and the American Public Transit Association (APTA) covers local travel. Very little data are collected on school buses. APTA figures are based on data from the USDOT, Federal Transit Administration's (FTA's) National Transit Database, which covers about 90 to 95 percent of total passenger-miles. These data are generally accurate because FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or may misinterpret data. APTA conservatively adjusts the FTA data to include transit operators that do not report to FTA, such as private and very small operators and rural operators. Prior to 1984, APTA did not include most rural and demand responsive systems.

## Air

The U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information (OAI) is the source of these data. The numbers are based on 100-percent reporting of fuel use by large certificated air carriers (those with revenues of more than \$100 million annually) via Form 41. The data are probably reasonably accurate because the airlines report fuel use regularly, and the limited number of airlines aids data management.

Smaller airlines, such as medium size regional and commuter air carriers, are not required to report energy data. OAI estimates that about 8 percent would have to be added to the total of the larger airlines to account for this use, but that has not been done in table 4-5 or 4-8.

General aviation aircraft and air taxis are covered in the General Aviation and Air Taxi and Avionics Survey, conducted by the Federal Aviation Administration (FAA). The survey is conducted annually and encompasses a stratified, systematic design from a random start to generate a sample of all general aviation aircraft in the United States. It is based on the FAA registry as the sampling frame. For instance, in 1997, a sample of 29,954 aircraft was identified and surveyed from an approximate

population of 251,571 registered general aviation aircraft.

The reliability of the GAATA survey can be impacted by two factors: sampling and nonsampling error. A measure, called the standard error, is used to indicate the magnitude of sampling error. Standard errors can be converted for comparability by dividing the standard error by the estimate (derived from the sample survey results) and multiplying it by 100. This quantity, referred to as the percent standard error, totaled seven-tenths of a percent in 1997 for the general aviation fleet. A large standard error relative to an estimate indicates lack of precision, and inversely, a small standard error indicates precision.

Nonsampling errors could include nonresponse, a respondent's inability or unwillingness to provide correct information, differences in interpretation of questions, and data entry mistakes. The reliability of general aviation fleet data comparisons over time would decrease because of changes implemented in 1978 and sampling errors discussed above. Readers should note that nonresponse bias may be a component of reliability errors in the data from 1980 to 1990. The FAA conducted telephone surveys of nonrespondents in 1977, 1978, and 1979 and found no significant differences or inconsistencies between respondent and nonrespondent replies. The FAA discontinued the telephone survey of nonrespondents in 1980 to save costs. Nonresponse surveys were resumed in 1990; and the FAA found notable differences and make adjustments to its data to reflect nonresponse bias.

The U.S. Government, in particular the Department of Defense (DOD), uses a large amount of jet fuel as shown in table 4-19 (see discussion on government consumption below). However, DOD reports all fuel purchased, including from foreign sources for operations abroad. While the data may be accurate, it is not comparable to EIA's overall U.S. supply and consumption figures on jet fuel.

International operations are included in table 4-8 but not table 4-5. The fuel use for international operations includes that purchased by U.S. airlines for return trips. OAI does not collect data on foreign airline purchases of fuel in the United States. Thus, a significant use of U.S. jet fuel is missed.

However, these two factors approximately balance each other out. As shown in table 1-34, foreign carrier traffic is just slightly less than U.S. carrier international traffic, so presumably the fuel purchased here by foreign carriers is very close to the fuel purchased abroad by U.S. carriers.

## Rail

The data are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). AAR figures are based on 100 percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual Report*. Thus, the data are considered accurate. STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the adjusted threshold for Class I railroads was \$259.4 million. Although Class I railroads represent only 2 percent of the number of railroads in the country, they account for over 70 percent of the industry's mileage operated and more than 90 percent of all freight revenue; energy consumption should be of the same order. For passenger travel, information is unavailable. Amtrak no longer provides data on a national basis, and the regional data appears to be inconsistent.

## Transit

The APTA figures are based on information in FTA's National Transit Data Base. APTA conservatively adjusts FTA data to include transit operators that do not report to the FTA Database (private and very small operators and rural operators), which accounts for about 90 to 95 percent of the total passenger-miles. The data are generally accurate because the FTA reviews and validates information submitted by individual transit agencies. Reliability may vary because some transit agencies cannot obtain accurate information or misinterpret certain data definitions in federal guidelines.

## Water

The EIA collects data on residual and distillate fuel oils and diesel through its *Annual Fuel Oil and Kerosene Sales Report* survey, form EIA-821. The survey targets companies that sell fuel oil and kerosene to end users. This survey commenced in 1984 and data from previous years should be used with caution.

## Sampling Frame and Design

The sample's target universe includes all companies that sell fuel oil and kerosene to end users. EIA derives the sampling frame from the EIA-863 database containing identity information for approximately 22,300 fuel oil and kerosene sellers. EIA stratifies the sampling frame into two categories: companies selected with certainty and uncertainty. Those in the certainty category varied but included the end use "vessel bunkering," or sales for the fueling of commercial and private watercraft.

## Sampling Error, Imputation, and Estimates

EIA reported a 91.3 percent response rate for the 1999 survey. The EIA also provides estimates of the sampling error for geographic areas and U.S. averages are 1.3 for residential distillate fuel oil, 0.9 for nonresidential retail distillate fuel oil, and 0.1 for retail residual fuel oil. Some firms inevitably ignore survey requests, causing data gaps. EIA estimates the volumes of these firm's sales by imputation; more detailed information and the algorithm can be obtained at EIA's web site in the technical notes for the Annual Fuel Oil and Kerosene Sales Report. See [http://www.eia.doe.gov/oil\\_gas/petroleum/data\\_publications/fuel\\_oil\\_and\\_kerosene\\_sales/foks.html](http://www.eia.doe.gov/oil_gas/petroleum/data_publications/fuel_oil_and_kerosene_sales/foks.html).

## TABLE 4-19. U.S. Government Energy Consumption by Agency and Source

Energy consumption data are collected by DOE's Office of Federal Energy Management Programs in cooperation with most departments and agencies. DOD is by far the largest consumer,

accounting for about 80 percent of the total. As discussed above, the data includes fuel purchased abroad for military bases. Since government agencies are required to report these data, they are probably accurate. However, it is possible that some consumption is missed. For example, some agencies may report only fuel supplied directly, missing consumption such as gasoline purchased by employees while on government business for which they are then reimbursed. In addition, smaller agencies were neglected. Overall, however, the data should provide a fairly good approximation of government energy consumption.

## ENERGY EFFICIENCY

### TABLE 4-20. Energy Intensity of Passenger Modes

### TABLE 4-21. Energy Intensity of Certificated Air Carriers, All Services

### TABLE 4-22. Energy Intensity of Passenger Cars, Other 2-Axle 4-Tire Vehicles, and Motorcycles

### TABLE 4-24. Energy Intensity of Transit Motor Buses

### TABLE 4-25. Energy Intensity of Class I Railroad Freight Service

### TABLE 4-26. Energy Intensity of Amtrak Service

Total energy consumed for each mode can be estimated with reasonable accuracy. Miles traveled are known for some modes, such as air carriers, but less accurately for others, most notably automobiles. When the numbers of passengers or tons are required to calculate energy efficiency, another uncertainty is introduced. Again, air carriers and intercity buses know how many passengers are on board and how far they travel, but only estimates are available for automobiles and intracity buses.

Thus, table 4-21 should be quite accurate for certificated air carriers, though it is missing small airlines and private aircraft. Table 4-22 is based on FHWA fuel tax data, derived from state fuel tax revenues. VMT is as discussed for tables 1-9 and

1-10. Data for motorcycles must be adjusted significantly more than for automobiles because less information is collected from the states or from surveys. Transit bus data (table 4-24) are very uncertain because, unlike intercity buses, the distance each passenger travels is not measured by ticket sales.

The intermodal comparison of passenger travel in table 4-20 must be viewed with considerable caution. Data for the different modes are collected in different ways, and the preparation of the final results is based on different assumptions. As noted above, airlines accurately record passenger miles, but the data on occupancy of private automobiles must be estimated from surveys. Even relatively certain data, such as state sales of gasoline, must be modified to resolve anomalies, and transit data are even harder to make consistent. Furthermore, different groups collect the data for the various modes, and they have different needs, assumptions, and methodologies. Thus, the comparisons are only approximate.

Freight service data (table 4-25) are from *Railroad Facts*, published annually by the Association of American Railroads (AAR). AAR figures are based on 100 percent reporting by Class I railroads to the Surface Transportation Board (STB) via Schedule 700 of the *R1 Annual Report*. STB defines Class I railroads as having operating revenues at or above a threshold indexed to a base of \$250 million (1991) and adjusted annually in concert with changes in the Railroad Freight Rate Index published by the Bureau of Labor Statistics. In 1998, the adjusted threshold for Class I railroads was \$259.4 million. Although Class I railroads comprise only 2 percent of the number of railroads in the country, they account for over 70 percent of the industry's mileage and 90 percent of all freight revenue; energy data should be of the same order.

### TABLE 4-27. Annual Wasted Fuel Due to Congestion

### TABLE 4-28. Wasted Fuel per Eligible Driver

The Texas Transportation Institute's (TTI) *Urban Roadway Congestion Annual Report* pro-



vided figures for tables 4-27 and 4-28. TTI relies on data from the U.S. Department of Transportation, Federal Highway Administration, Highway Performance Monitoring System database (HPMS). (See box 1-1 for detailed information about the HPMS.) TTI utilizes these data as inputs for its congestion estimation model. Detailed documentation for the TTI model and estimations can be found at <http://mobility.tamu.edu/study/index.stm>.

The sum of fuel wasted in typical congestion (recurring delay) and incident related delays equal the annual wasted fuel for an urban area. Recurring delay is the product of recurring delay (annual hours in moderate, heavy, and severe delays) and average peak period system speed divided by average fuel economy. Incident delay hours are multiplied by the average peak period system speed and divided by the average fuel economy to produce the amount of incident fuel wasted.

### Structure, Assumptions, and Parameters

Urban roadway congestion levels are estimated using a formula measuring traffic density. Average daily travel volume per lane on freeways and principal arterial streets are estimated using area wide estimates of vehicle-miles of travel and lane miles of roadway. The resulting ratios are combined using the amount of travel on each portion of the system (freeway and principal arterials) so that the combined index measures conditions overall. This variable weighting factor allows comparisons between areas such as Phoenix where principal arterial streets carry 50 percent of the amount of travel of freeways and cities such as Phoenix where the ratio is reversed. Values greater than one are indicative of undesirable congestion levels. Readers seeking the algorithm for the congestion index should examine <http://mobility.tamu.edu/study/numbers.stm>.

In previous reports, TTI assumed that 45 percent of all traffic, regardless of the urban location, occurred in congested conditions. TTI indicated that this presumption overestimated travel in congested periods. Its 1997 estimates now vary by urban area anywhere from 21 to 50 percent of travel that occurs in congestion. TTI's model

structure applies to two types of roads: freeways and principal arterial streets. The model derives estimates of vehicle traffic per lane and traffic speed for an entire urban area. Based on variation in these amounts, travel is then classified under 5 categories: uncongested, moderately congested, heavily congested, severely congested, and extremely congested (a new category in 1999). The threshold between uncongested and congested was changed in 1999. Previous editions classified congested travel when area wide traffic levels reached 13,000 vehicles per lane per day on highways and 5,000 vehicles per lane per day on principal arterial streets. These thresholds were raised in the latest report to 14,000 and 5,500 vehicles per lane per day respectively. Comparisons across time will be questionable due to these changes. For example, TTI applied the new methodology to 1996 data that resulted in lower congestion levels. Readers should refer to the TTI website for more detailed information on its estimation procedures [http://mobility.tamu.edu/estimating\\_mobility](http://mobility.tamu.edu/estimating_mobility).

TTI reviews and adjusts the data used in its model, including statewide average fuel cost estimates (published by the American Automobile Association) and the number of eligible drivers for each urban area (taken from the Statistical Abstract of the United States, published by the U.S. Department of Commerce, Bureau of the Census). The model has some limitations because it does not include local variations (such as bottlenecks, local travel patterns, or transportation improvements) that affect travel times. TTI documentation does not provide information on peer-review, sensitivity analysis, or estimation errors for their model. Information about sensitivity analysis or external reviews of the model could not be obtained and users should interpret the data cautiously.

## ENVIRONMENT

**TABLE 4-38. Estimated National Average Vehicle Emissions Rates by Vehicle Type and Fuel**

**TABLE 4-39. National Average Vehicle Emissions Rates by Vehicle Type Using Reformulated Gasoline**

The U.S. Environmental Protection Agency uses its Mobile Source Emissions Factor Model (MOBILE) to generate average emissions factors for each vehicle and fuel type. The methods used in the model are theoretically sound, the assumptions are reasonable, but the data vary in quality, and no formal analysis of the accuracy of these estimates has been performed. Emissions rate estimates for light-duty vehicles are considered more reliable than those for heavy-duty vehicles because in-use emissions tests are performed on a sample of vehicles each year. Deterioration for heavy-duty vehicles in the national fleet are based only on manufacturer's engine deterioration tests. In addition, because reformulated fuels (table 4-37) are newer than other gasoline fuels (table 4-36), in-use emissions test data for reformulated fuels are not as extensive.

The estimates in the tables represent average emissions rates taking into account the characteristics of the nation's fleet, including vehicle type and age, and fuel used. The model also assumes Federal Test Procedure conditions. The model does not take into account actual travel distributions across different highway types with their associated average speeds and operating mode fractions, nor do they consider ambient local temperatures. However, fleet composition and deterioration because of age are considered. Thus, these rates illustrate only trends due to vehicle emissions control improvements and their increasing use in the national fleet and should not be used for other purposes.

**TABLES 4-40, 4-41, 4-42, 4-43, 4-44, 4-45 and 4-46. Estimates of National Emissions of Carbon Monoxide, Nitrogen Oxides, Volatile Organic Compounds, Particulate Matter, Sulfur Dioxide, and Lead**

Emissions by sector and source are estimated using various models and calculation techniques and are based on a number of assumptions and on data that vary in precision and reliability. The methods used are theoretically sound, the assumptions are reasonable, but the data vary in quality, and no formal analysis of the accuracy of these estimates has been performed.

**Carbon Monoxide (CO), Nitrogen Oxides (NO<sub>x</sub>), and Volatile Organic Compounds (VOCs)**

Highway vehicle emissions of CO, NO<sub>x</sub>, and VOC are generated by the U.S. Environmental Protection Agency's (EPA's) Mobile Source Emissions Factor Model (MOBILE), which uses per-mile vehicle emissions factors and vehicle travel (vehicle-miles) to calculate county-level emissions. Emissions rates are then adjusted based on fuel characteristics, vehicle fleet composition, emissions control measures, average vehicle speed, and other factors that can affect emissions. (Emissions rates used in MOBILE are based on vehicle certification tests, emissions standards, and in-use vehicle tests and are updated approximately every three years.) The U.S. Department of Transportation, Federal Highway Administration's Highway Performance Monitoring System is the source of vehicle travel estimates used in the model. Although the methodology for this survey data is sound and well documented, analyses have shown that individual states vary in how rigorously they follow the established sampling guidelines.

Nonhighway vehicle emissions are calculated by applying a growth factor (based on modal activity trends) to modal emissions estimates from the most recently conducted state emissions inventories. These emissions inventories are typically estimated every three years in accordance with the Clean Air Act of 1970,<sup>1</sup> but the methodology may vary among states and by year.

**Particulate Matter Under 10 Microns (PM-10) and 2.5 Microns (PM-2.5) in Size**

Highway vehicle emissions are estimated using the U.S. Environmental Protection Agency's PART model, which estimates emissions factors for exhaust emissions and brake and tire wear by vehicle type. Exhaust emissions factors are based on certification tests, while brake wear (per vehicle) and tire wear (per tire) are assumed values which are constant over all years. Per-mile emissions factors are multiplied by vehicle travel (vehicle-miles) and adjusted to account for other factors that effect exhaust emissions (e.g., fuel composition, weather,

<sup>1</sup> Public Law 91-604, 84 Stat. 1705 (December 31, 1970).

etc.). The U.S. Department of Transportation, Federal Highway Administration's Highway Performance Monitoring System is the source of vehicle-miles of travel (vmt) estimates used in the model. While the methodology for this survey data is sound and well documented, analyses have shown that individual states vary in how rigorously they follow the established sampling guidelines.

Fugitive dust estimates for paved and unpaved roads are calculated by multiplying vmt on each type of road by emissions factors for each vehicle type and road type.

Nonhighway vehicle emissions are calculated by applying a growth factor (based on modal activity trends) to modal emissions estimates from the most recently conducted state emissions inventories. These emissions inventories are typically estimated every three years in accordance with the Clean Air Act of 1970, but the methodology may vary among states and by year.

### Sulfur Dioxide (SO<sub>2</sub>)

Highway vehicle SO<sub>2</sub> emissions are estimated by multiplying vehicle travel (for each vehicle type and highway type) by an emissions factor reflecting each vehicle type and highway type. Highway SO<sub>2</sub> emissions factors are based on vehicle type and model year, sulfur content of fuel by type and year, fuel density by fuel type, and vehicle fuel efficiency by type and model year.

In general, estimates for nonhighway vehicles are calculated based on fuel consumption and sulfur content of fuel, though other factors may be considered.

### Lead

In general, lead emissions are estimated by multiplying an activity level by an emissions factor that represents the rate at which lead is emitted for the given source category. This estimate is then adjusted by a factor that represents the assumed effectiveness of control technologies. For lead released during combustion, a top-down approach is used to share national estimates of fuel consumption by fuel type to each consumption category (e.g., motor fuel, electric utility, etc.) and,

subsequently, each source (e.g., passenger cars, light-duty trucks, etc.).

### TABLE 4-47. Air Pollution Trends in Selected Metropolitan Statistical Areas (MSAs)

### TABLE 4-48. Areas in Nonattainment of National Ambient Air Quality Standards for Criteria Pollutants

The U.S. Environmental Protection Agency measures concentrations of pollutants in the ambient air at its air quality monitoring sites, which are operated by state and local agencies. These sites conform to uniform criteria for monitor siting, instrumentation, and quality assurance, and each site is weighted equally in calculating the composite average trend statistics. Furthermore, trend sites must have complete data for 8 of the 10 years in the trend time period to be included. However, monitoring devices are placed in areas most likely to observe significant concentrations of air pollutants rather than a random sampling of sites throughout the nation.

### TABLE 4-49. U.S. Carbon Dioxide Emissions from Energy Use by Sector

The combustion of fossil fuels, such as coal, petroleum, and natural gas, is the principal anthropogenic (human caused) source of carbon dioxide (CO<sub>2</sub>) emissions. Since fossil fuels are typically 75 percent to 90 percent carbon by weight, emissions from the combustion of these fuels can be easily measured in carbon units, as is shown in the table.

CO<sub>2</sub> emissions data are derived from estimates. The U.S. Department of Energy, Energy Information Administration (EIA), estimates CO<sub>2</sub> emissions by multiplying energy consumption for each fuel type by its carbon emissions coefficient, then subtracting carbon that is sequestered by nonfuel use of fossil fuels. Carbon emissions coefficients are values used for scaling emissions to specific activities (e.g., pounds of CO<sub>2</sub> emitted per barrel of oil consumed).

Emissions estimates are based on energy consumption data collected and published by EIA. Several small adjustments are made to its energy consumption data to eliminate double counting or miscounting of emissions. For example, EIA subtracts the carbon in ethanol from transportation gasoline consumption because of its biological origin.

Emissions coefficients are based on the density, carbon content, and heat content of petroleum products. For many fuels, except liquefied petroleum gas (LPG), jet fuel, and crude oil, EIA assumed coefficients to be constant over time. For LPG, jet fuel, and crude oil, EIA annualized carbon emissions coefficients to reflect changes in chemical composition or product mix.

Since the combustion of fossil fuels is a major producer of CO<sub>2</sub> emissions, sources of uncertainty are related to: 1) volumes of fuel consumed; 2) characteristics of fuel consumed; 3) emissions coefficients; and 4) coverage. EIA notes that volumetric fuel data are fairly reliable in the 3 percent to 5 percent range of uncertainty. The density and energy content of fuels are usually estimated. According to EIA, the reliability of these estimates vary. For example, estimates of the energy content of natural gas are reliable to 0.5 percent, while estimates for coal and petroleum products are lower because they are more heterogeneous fuels. The reliability of emissions coefficients depends on whether the characteristics of a fuel are difficult to measure accurately. Finally, uncertainties may result because data may be excluded or unknown sources of emissions not included.

EIA's estimation methods, emissions coefficients, and the reliability of emissions estimates are discussed in detail in U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States, 1998* available on [www.eia.doe.gov/oiaf/1605/ggrpt/index.html](http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html).

**TABLE 4-50. Annual Oil Spills in U.S. Navigable Waters by Vessel Type**

The U. S. Coast Guard's (USCG) Marine Safety Information System (MSIS) is the source of these

data. It includes data on all oil spills impacting U.S. navigable waters and the Coastal Zone. The USCG learns of spills through direct observation, reports from responsible parties and third parties. Responsible parties are required by law to report spills to the National Response Center (NRC). Reports may be made to the USCG or Environmental Protection Agency pre-designated On Scene Coordinator for the geographic area where the discharge occurs if direct reporting to the NRC is not practicable. There is no standard format for these reports, but responsible personnel face significant penalties for failing to do so. Most reports are made by telephone, and USCG personnel complete investigations based on the information provided. The type and extent of an investigation conducted varies depending on the type and quantity of the material spilled. Each investigation will determine as closely as possible source of the pollutant, the quantity of the material spilled, the cause of the accident, as well as whether there is evidence that any failure of material (either physical or design) was involved or contributed to the incident. These are so financial responsibility may be properly assigned for the incidents, as well as proper recommendations for the prevention of the recurrence of similar incidents may be made.

Some spills may not be entered into MSIS because they are either not reported to or discovered by the USCG. The probability of a spill not being reported is inversely proportional to its size. Large spills impact a large area and a large number of people, resulting in numerous reports of such spills. Small spills are less likely to be reported, particularly if they occur at night or in remote areas where persons other than the responsible party are unlikely to detect them. Responsible parties are required by law to report spills and face penalties for failing to do so, providing a strong incentive to report spills that might be detected by others. Experience with harbor patrols shows that the number of spills increases as the frequency of patrols increases. However, the volume of material spilled does not increase significantly, indicating that the spills discovered through increased harbor patrols generally involved very small quantities.

## Data Collection

From 1973 to 1985, data were collected on forms completed by the investigator and later entered into the Pollution Incident Reporting System (PIRS) by data entry clerks at USCG headquarters. Since 1985, data have been entered directly into MSIS by the investigator. From 1985 to 1991, data were entered into a specific electronic form that captured information on the spilled substance and pollution response actions. Since 1995, a growing number of reports of pollution incidents of 100 gallons or less of oil have been captured on a Notice of Violation ticket form, which are then entered into MSIS.

The information shown in this table comes from the USCG Spill Compendium, which contains spill data from the applications described above. The Compendium contains summary data from 1969 through 1999 and is intended to provide general information to the public, the maritime industry and other interested persons about spills in and around U.S. waterways. For more information about spill data, please refer to the USCG Internet site at <http://www.uscg.mil/hq/gm/nmc/response/stats/aa.htm>.

## Nonsampling Errors

According to the USCG, nonsampling errors, such as nonreporting and mistakes made in data collection and entry, should not have a major impact on most interpretations of the data, but the impact will vary depending on the data used. The error rate for volume spilled is estimated to be less than 5 percent because larger spills, which account for most of the volume of oil spilled, are thoroughly reviewed at several levels. The error rate for the number of spills is difficult to estimate primarily due to low reporting rates for small spills. Most of the error in spill counts involves spills of less than 100 gallons.

**TABLE 4-51. Leaking Underground Storage Tank Releases and Cleanups**

A national inventory of reported spills and corrective actions taken for leaking underground storage tanks is compiled biannually based on

state counts of leaking tanks reported by owners as required by the Resource Conservation and Recovery Act of 1976.<sup>2</sup> These data may be affected by general accounting errors, some of which have changed semiannual counts by as many as 2,000 actions.

**TABLE 4-52. Highway Noise Barrier Construction**

State highway agencies (SHAs) provide data on highway noise barrier construction, extent, and costs to the U.S. Department of Transportation, Federal Highway Administration. Individual SHA definitions of barriers and costs may differ. This could lead to nonuniformity and/or anomalies among state data, which will in turn affect national totals.

**TABLE 4-53. Number of People Residing in High-Noise Areas Around U.S. Airports**

The number of the people exposed to aircraft noise around airports is estimated by computer modeling rather than by actual measurements. The U.S. Department of Transportation (USDOT), Federal Aviation Administration's (FAA's) Integrated Noise Model (INM) has been the primary tool for assessing aircraft noise around airports for nearly 30 years. This model uses information on aircraft mix, average daily operations, flight tracks, and runway distribution to generate and plot contours of Day Night Sound Level (DNL). With the addition of a digitized population census database, the model can estimate the number of residents exposed to noise levels of 65 decibels (db) DNL.

The U.S. Environmental Agency (EPA) produced the first estimate of airport noise exposure in 1975. It reported that 7 million residents were exposed to significant levels of aircraft noise in 1978. This number became the "anchor point" for all future estimates of the nationwide noise impacts. In 1980, FAA developed another methodology for estimating the change in the number

<sup>2</sup> Public Law 94-580, 90 Stat. 2795 (October 21, 1976).

of people impacted by noise (from the 1975 anchor value) as a function of changes in both the national fleet and in the FAA's Terminal Area Forecast (TAF). In 1990, the FAA created an improved method of estimating the change in number of people impacted (relative to the 1980 estimates).

In 1993, the FAA began using its newly developed Nationwide Airport Noise Impact Model (NANIM) to estimate the impact of airplane noise on residential communities surrounding U.S. airports that support jet operations. FAA uses this model to determine the relative changes in number of people and land area exposed to 65 db DNL as a result of changes in nationwide aircraft fleet mix and operations. NANIM uses data on air traffic patterns found in the Official Airline Guide (OAG), air traffic growth projections found in FAA's TAF, population figures from the U.S. Census Bureau, and information on noise contour areas for the top 250 U.S. civil airports with jet operations.

The methodology used in NANIM has been peer reviewed and approved. However, a formal evaluation of the model's accuracy has not been conducted. Some data used in NANIM are updated manually, thus the possibility of data entry errors does exist. Entries are reviewed and then corrected as appropriate. The aircraft mix and operations files from FAA's TAF and OAG are updated automatically. Changes to either of the sources could introduce errors. For example, it was recently discovered that OAG redefined some aircraft codes and altered some data fields in its database. These changes make it impossible for the NANIM utility program to accurately read the current OAG database. A rewrite of the source code is necessary to eliminate this error. Also, since airport authorities are not required to produce noise exposure maps and reports unless they intend to apply for Federal grants, 14 of the 50 busiest commercial airports, including JFK and LaGuardia, have not produced (for public consumption) noise exposure maps in several years. In the absence of actual data, the NANIM database contains approximations of the noise contours areas based on airports of similar size and similar operation. Without actual airport data, it is impossible to quantify the error introduced by the approximation.

## TABLE 4-54. Motor Vehicles Scrapped

The Polk Company's Vehicles in Operation database is the source of these data. This database is a census of vehicles that are currently registered in all states within the United States. It is based on information from state department of motor vehicles. Polk updates the database quarterly (March, June, September, and December).

Scrapped vehicles are those that Polk removes from its database when: 1) States indicate registered vehicles have suffered major damage (such as a flood or accident), or 2) No renewal (reregistration) notice is received by Polk within a state's allotted time (normally one year). In the latter case, if a vehicle is subsequently reregistered, it is returned to the database. The Polk data on motor vehicles is broken down into passenger cars and trucks, and this identification comes with the registration data from the DMV.

## REFERENCES

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